

CALIFORNIA
ENERGY
COMMISSION

**PUBLIC INTEREST ENERGY RESEARCH
2009 ANNUAL REPORT**

REPOWERING FOR CLEAN TECHNOLOGY

DRAFT COMMITTEE REPORT

March 2010
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Abstract

The Public Interest Energy Research (PIER) program was created in 1996 when the state Legislature enacted Assembly Bill 1890 (Brulte, Chapter 854, Statutes of 1996), California's electric utility restructuring legislation. This law shifted the administration of public interest energy-related research, development, and demonstration (RD&D) from California's investor-owned utilities to state government—a major change intended to ensure the continuation of public interest energy RD&D.

Similar legislation was enacted in 2000 with Assembly Bill 1002 (Wright, Chapter 932, Statutes of 2000), which required the California Public Utilities Commission (CPUC) to impose a surcharge on all natural gas consumed in California to fund public interest research and development activities specific to natural gas. In 2004, the CPUC designated the Energy Commission as the administrator for the natural gas research program. The California Energy Commission manages the electricity research program and the natural gas research program through its PIER program.

The Energy Commission's *Public Interest Energy Research (PIER) 2009 Annual Report* is prepared under Public Resources Code Section 25620.8. This report covers RD&D projects funded in the period from January 1, 2009, through December 31, 2009. In 2009, the California Energy Commission administered a total of \$86.5 million for research through the PIER Program—\$62.5 million for electricity and \$24 million for natural gas RD&D projects.

The Energy Commission supports public interest energy research, development, and demonstration for energy efficiency and demand response, renewable energy resources, advanced electricity generation, transmission and distribution, transportation, and energy-related environmental research that is not adequately provided for by competitive and regulated markets. This latest annual report highlights recently funded research, notable results from ongoing and completed projects, and research initiatives that will help lead California into the clean energy future.

Keywords: California Energy Commission, PIER, annual report, 2009, energy research, RD&D, energy efficiency, climate change, advanced generation, renewable energy, demand response, energy storage, transmission, distribution, infrastructure, buildings, distributed generation, smart grid, carbon sequestration, carbon capture, transportation

CHAPTER 1:

Repowering California through Energy Research, Development, and Demonstration

In the 2010 State of the Union address, President Obama stated, "...energy efficiency and clean energy are the right thing to do for our future – because the nation that leads the clean energy economy will be the nation that leads the global economy." California leads the nation in energy efficiency and clean energy through its energy efficiency measures, clean technologies, greenhouse gas reduction goals, and forward thinking energy policies. Many of these measures, technologies, and policies originated at the California Energy Commission as products of its mission of improving energy systems that promote a strong economy and a healthy environment. Maintaining this market leadership and growth of the clean energy economy requires continual evaluation, investment, and proof-of-concept success to accelerate energy technology advances, reduce manufacturing and product costs, and enhance consumer acceptance of new products and business practices. The Energy Commission's Public Interest Energy Research (PIER) Program¹ will provide clean technologies to repower California's electric system and create lasting jobs for a strong 21st century economy.

Energy Commission Expertise

The Energy Commission through the PIER program conducts research, development, and demonstrations (RD&D) that provide tangible benefits to electricity and natural gas ratepayers through investments in the following areas:

- Increased energy efficiency in buildings, appliances, lighting, and other applications beyond applicable standards.
- Advanced electricity technologies that reduce or eliminate consumption of water or other finite resources, increase use of renewable energy resources, or improve transmission or distribution of electricity generated from renewable energy resources
- Advanced electricity generation technologies that exceed applicable standards to increase reductions in greenhouse gas emissions from electricity generation.
- Advanced transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards.²

The Commission is the state's primary energy policy and planning agency. With energy challenges facing the state, the Commission and its staff turn challenges into opportunities and help Californians have energy choices that are affordable, reliable, diverse, safe, and environmentally preferred. For example, federal stimulus money became available in 2009 through the American Recovery and Reinvestment Act (ARRA). The Commission seized this opportunity to leverage federal funding by advocating on behalf of California projects and providing cost share funding for entities requesting funds for California energy demonstration and deployment projects. As a result of these public-private partnerships, a large number of California stimulus applicants have been successful in bringing more than a billion dollars

1 The PIER program was created in 1996 when the state Legislature enacted Assembly Bill 1890 (Brulte, Chapter 854, Statutes of 1996), California's electric utility restructuring legislation.

2 Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006) extended the authority of the Energy Commission to administer the electricity research funds through 2011 and clarified the investment categories eligible for PIER funding.

worth of ARRA-funded projects to California. One of these projects, the Sacramento Municipal Utility District's "SmartSacramento" smart grid project, will bring \$127.5 million in federal funds to California through 2012.

The Commission has already committed \$14 million in cost-share funding to ARRA awardees, totaling \$683 million worth of projects located in California. The Commission pledged an additional \$20 million of PIER research funds in anticipation of more ARRA federal grants awarded to California projects. The infusion of ARRA money will expedite the advancement of California's electricity grid to accommodate intermittent renewable energy projects and expand California's clean energy technology base at a pace that would normally take decades, based upon existing funding.

PIER Research Supports Energy Policies and Goals

The Commission's responsibility for energy policy and planning ensures that the PIER program helps to implement state energy policies. These policies include state legislation, the *Integrated Energy Policy Reports* and executive orders. The Commission provides for public input and review by having all proposed PIER research projects approved at public Commission business meetings.

The state's main energy policy document is the biennial *Integrated Energy Policy Report (IEPR)*, which evaluates overall supply and demand trends for electricity, natural gas, and transportation fuels in California, as well as issues associated with energy infrastructure, efficiency, reliability, and cost. The *2009 IEPR* describes the various energy policies significantly affecting California. Three of these policies – Assembly Bill 32 (Nuñez, Chapter 488, Statutes of 2006) and Executive Orders S - 14 - 08 and S - 21 - 09 – reaffirm the Commission's research for "increased development of renewable electricity sources, energy efficiency and demand response ... to meet the greenhouse gas reduction goal of 1990 levels by 2020 and 80 percent below 1990 emissions levels by 2050."³ Executive Order S-21-09 accelerated the Renewable Portfolio Standard to 33 percent renewable energy generation by 2020. Furthermore, the Energy Commission and California Air Resources Board have adopted goals to reduce on-road and off-road petroleum transportation use by 26 percent by 2022 (AB 1007 Report adoption).

Energy Commission research, development, and demonstrations (RD&D) provide new technologies, tools, standards, and protocols to help implement these energy policies. The *2009 IEPR* recommendations coincide with the state policy, known as the loading order, which prioritizes the development of new energy resources as follows:

1. Increasing energy efficiency and demand response
2. Integrating renewable energy resources and distributed generation resources, including energy storage
3. Advancing clean fossil - fueled generation
4. Improving the state's transmission infrastructure

The Commission's research investments and the loading order reflect many of the state's energy policies. Commission research not only follows but also affects energy policies.

Title 24, California's Building Energy Efficiency Standards is one of the state's major energy policies. This standard is one key element of the state's long-term success in ensuring high levels of energy efficiency. The Commission updates these residential and commercial building efficiency standards every three years to maintain leadership in incorporating technological

3 Governor of the State of California, Executive Order S 21 09

advances aided by Commission research and advances in the marketplace. Commission research contributed to 11 measures that were included in the 2008 Title 24 Building Energy Efficiency Standards that took effect in January 2010. For example, Commission research developed *cool roof* products for residential buildings. These products are now available from a variety of manufacturers, including the GAF roof shown in Figure 1.

Figure 1: Cool Roof for Residential Buildings



House with Cool Barkwood roofing material
Photo Credit: GAF Materials Corporation

Requirements for cool roofing products are now incorporated into Title 24, and residential roofing materials are expected to provide at least \$1.45 in life cycle cost savings per square foot of roofing. One hundred square meters of a white roof, replacing a dark roof, offsets the emission of ten metric tons of carbon dioxide. For the average house with 2,000 square feet of roofing, this is roughly equivalent to the carbon emissions from four cars every year.

The Commission has funded projects that developed products and technologies used by California consumers. As an example, research showed that installing an in-slab tubing system, with circulating cold water to cool floor slabs, can be used to provide sufficient cooling in big box stores. The large surface area of the slab provided effective cooling. This design led to a 70 percent reduction in air conditioning cost compared to conventional rooftop air conditioning units (see Chapter 3). This system is marketed by Viega as Climate Mat, and is being installed in Walmart stores.

The 21st century grid will have distributed energy technologies, including renewable energy resources, distributed generation, and energy storage. Properly integrating these technologies into the existing electric system is a problem that system models can help address. New Power Technologies' Energynet™ methodology demonstrated that models using conventionally maintained utility system data could provide visibility into network conditions down to the customer level, even where existing system monitoring is sparse. Energynet's demonstration with Southern California Edison, involving data from 280,000 customers, was done at a fraction of the cost compared to smaller smart grid demonstrations in other states. This project identified where distributed energy resources can be located to improve power quality and alleviate transmission grid congestion in California. Using such proven power system tools will support future smart grid applications, allowing utilities to optimize system performance with properly sized equipment including transformers, energy storage systems, and renewable energy generators.

PIER's microgrid projects demonstrate how applying smart grid technologies can support integrating renewable resources and enhance transmission and distribution capabilities. In May 2009, the Commission funded San Diego Gas & Electric (SDG&E) to demonstrate how smart grid technologies can coordinate and manage various integrated distributed resources. This demonstration is taking place in Borrego Springs, California, an area with an average of nine blackouts per year. Borrego Springs is an isolated desert community with a high amount of customer-owned rooftop solar systems. SDG&E will add energy storage and controls to coordinate these renewable resources and increase electric reliability. Ratepayers will have the capability to manage their electric use through newly installed smart meters. SDG&E will evaluate the microgrid performance to apply lessons learned to the implementation of the smart grid.

A product developed to improve the transmission system was fully commercialized in 2009. Now in use at the operation centers of the California Independent System Operator (ISO), Bonneville Power Administration (BPA), Tennessee Valley Authority (TVA), and all seven centers within the Eastern Interconnection, the Phasor-RTDMS™ software from the Electric Power Group is a real-time utility grid monitoring application. The software uses streaming, time-synchronized data to provide meaningful operational information for reliability and performance operations, including wide-area monitoring and visualization, and dashboard display for situational awareness. Time-synchronized phasor systems provide the MRI-equivalent of the power system as compared with the traditional utility operations systems, which are like x-rays. This software will increase reliability and help prevent cascading blackouts.

Every product begins with research to prove a technology concept. This stage is the first and most difficult step to commercialization for small businesses and individuals. Many future products will never be marketed without assistance in achieving this first step. The Commission recognizes this need and operates the Energy Innovations Small Grants (EISG) program. This research program targets small businesses, individuals, non-profit organizations, and academics to be able to participate in all areas of PIER research. The goal of this program is to move promising ideas past the first stages of research for further development toward commercialization by venture capitalists or other funding resources.

In 2009, the San Francisco-based company, ThermAvant Technologies, LLC, received an EISG grant to demonstrate a solar air conditioning system. Air conditioners greatly increase the demand for electricity on hot, sunny days. The goal of this project is to determine the feasibility of a heat-activated ejector cooling system for buildings. This type of system can be used to help the state reduce its peak demand for electricity, while providing low cost cooling for Californians.

In addition to reducing peak demand, environmentally-preferred advanced generation technologies are being developed to supply peak energy. One option is to use fuel cells, traditionally thought of as a baseload resource due to their narrow operating parameters. Use of high-temperature fuel cells is appealing because they theoretically could respond quickly to perturbations in the grid. The EISG program awarded the University of California (UC) Irvine's National Fuel Research Center a grant to develop and model control systems and strategies to maintain fuel cell temperature profiles needed to respond to peak energy demand. If successful, fuel cells could be used as a peak demand energy resource, replacing the more inefficient fossil fuel "peaker plants" that are online today.

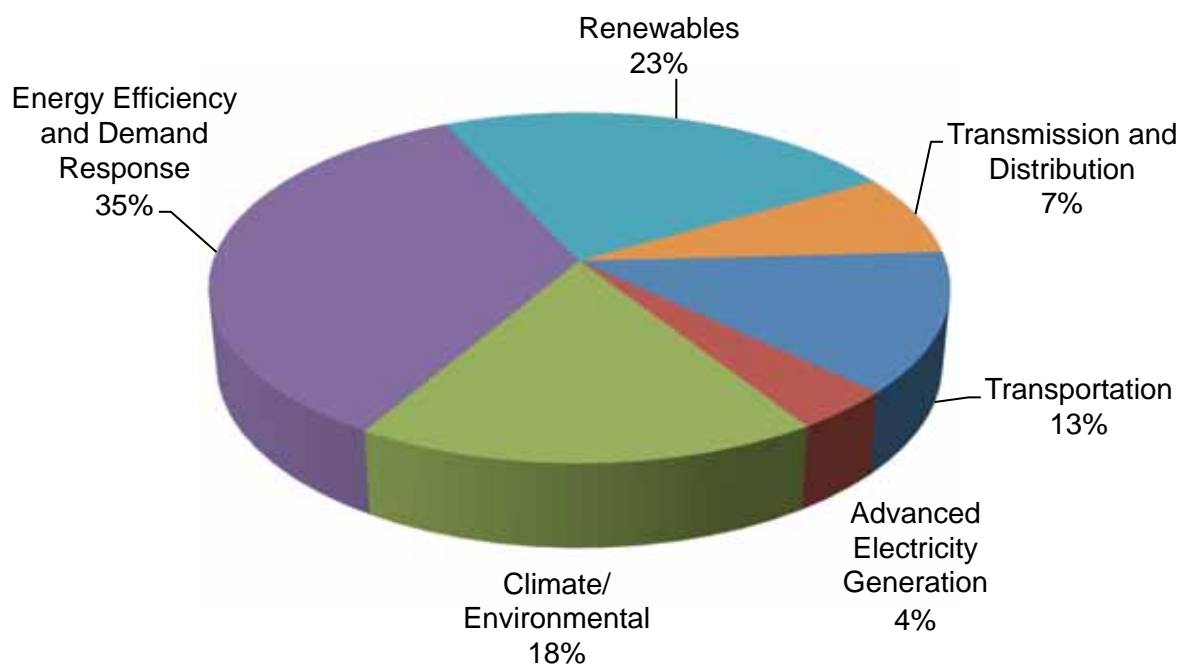
Future projects will also benefit from Commission-funded research. Two projects awarded funding by the *American Recovery and Reinvestment Act of 2009* (ARRA) will deploy lighting technologies developed from Commission-funded research, including wireless lighting controls, smart parking lot fixtures, integrated office lighting systems, and simplified daylighting controls.

This report describes the RD&D activities and accomplishments made possible through the Public Interest Research, Development, and Demonstration Fund. Chapter 2 explains how PIER uses its funds to bring to California additional money and energy research expertise that benefit California ratepayers and the economy. Chapter 3 highlights significant Commission-funded research conducted or initiated in 2009 that brings the latest and emerging technologies to California, including the first LED downlight fixture to receive Energy Star® certification and an energy-efficient thermoelectric heating ventilation and air conditioning (HVAC) system for vehicles. Chapter 4 describes PIER's future research that will emphasize repowering California for clean technology. The Appendix contains a summary list of the RD&D projects that were active in 2009.

CHAPTER 2: Leveraging Funds and California Expertise to Help Solve the State's Energy Issues

The Commission uses multiple funding streams and wide-ranging expertise from a variety of sources to perform electricity and natural gas RD&D. Figure 2 shows the 2009 PIER electric and natural gas budget allocations by major investment area.

Figure 2: 2009 PIER Electric and Natural Gas Research Budget Allocations

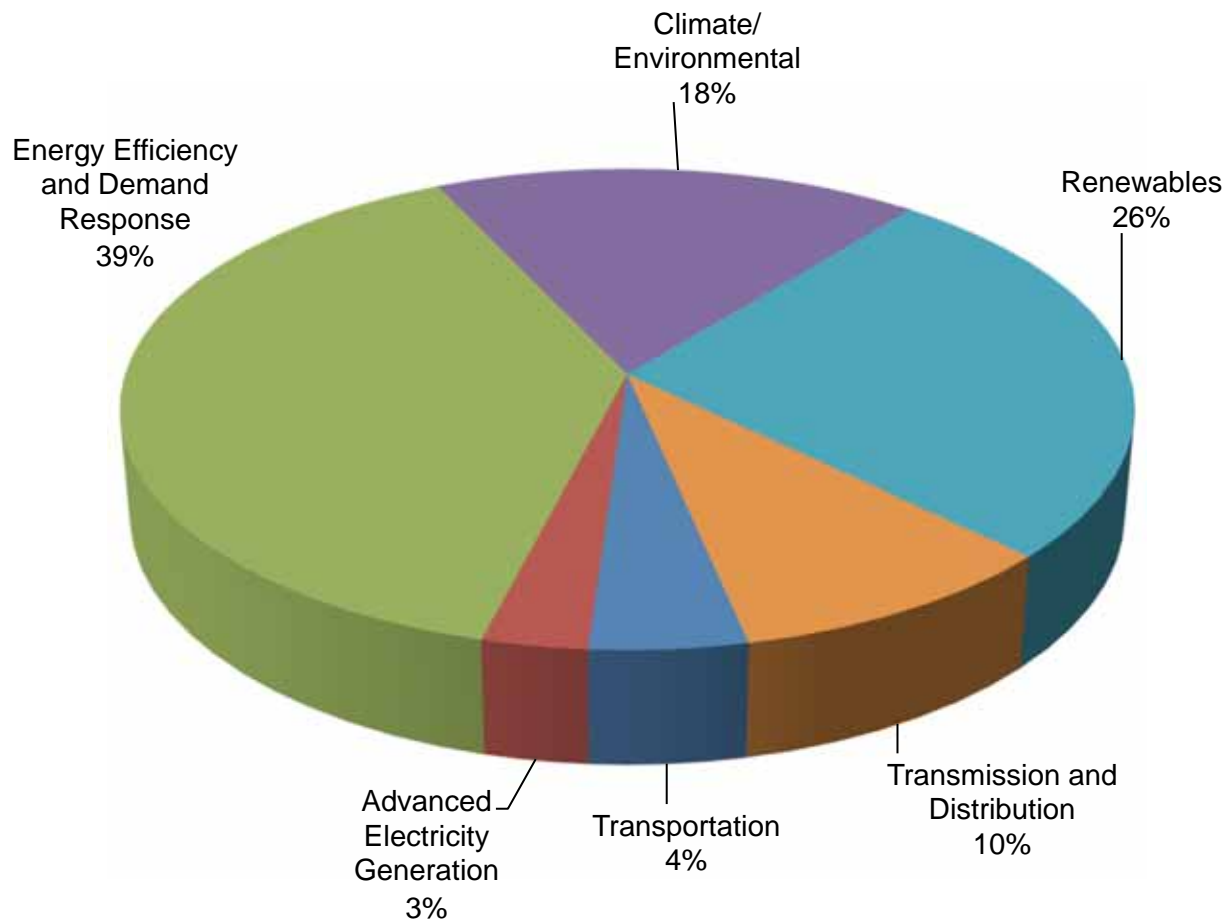


Source: California Energy Commission

Figure 3 shows the 2009 PIER electric research funds by the same investment areas according to the SB 1250 goals.

The Commission leverages the combined \$86.5 million PIER budget in distinct ways to maximize benefits for California ratepayers. In 2009, the four major leveraging approaches included: 1) leveraging maximum federal American Reinvestment and Recovery Act funds; 2) leveraging cost shares from other research partners for investments in California technologies; 3) leveraging funds across different PIER programs; and 4) leveraging technical expertise from within the state from utilities, universities, energy industries, other state agencies and federal agencies to stimulate higher quality research.

Figure 3: 2009 PIER Electric Research Budget Allocations



Source: California Energy Commission

Opportunity Knocks – Leveraging Maximum Federal ARRA Funds

In response to the current economic crisis, the federal government created the federal *American Reinvestment and Recovery Act of 2009* (ARRA), which included more than \$62 billion in energy related grants. This federal legislation presented an opportunity to improve California's energy infrastructure faster than what would otherwise be possible using only state funds. Although not initially included in the PIER research portfolio for the 2009-2010 fiscal year, the portfolio was significantly revised to bring as much ARRA funding to California as possible. The Commission recognized the ARRA funding could expand the job opportunities in California; allow California companies to highlight their products, skills, and expertise throughout the nation and the world; and help the state become the center of the oncoming clean technology revolution.

To date, the Energy Commission has committed \$14 million in cost-share funds to these companies, resulting in more than \$386 million in U.S. Department of Energy (DOE) federal ARRA funds to California companies and leveraging an additional \$283 million in third-party cost-share funding (see Table 1). The state is providing \$14 million in funding to leverage more

than \$669 million in additional funding, which resulted in a leveraging ratio greater than 48 to 1 for clean technology implementation in California.

Table 1: ARRA-Leveraged Funding (in millions)

	PIER Program Funds	DOE ARRA Funds Into California	Third Party Cost Share Funds for California Projects	TOTAL
Approved or Awarded Grants	\$14	\$386	\$283	\$683
		\$669		
Potential Awards for future ARRA Federal Grants	\$20	\$500-\$800	\$200-\$500	\$720-1320

Source: California Energy Commission

Through this effort, PIER has connected with companies working across the state. Figure 4 shows the locations of the ARRA and Commission co-funded projects in California, which have been announced to date, and a list of the key organizations involved in their development.

Figure 4: Location Map of ARRA Projects in California and List of Project Participants



Source: California Energy Commission

The Commission continues to work with California-based ARRA applicants. Anticipating that California applicants may receive additional ARRA awards for already-submitted projects, the Commission has set aside an additional \$20 million in co-funding for these California projects.

ARRA Accelerating Technology

ARRA-funded projects accelerate advancements in technology and manufacturing that otherwise may not have taken place until the next decade or later. The Commission will monitor progress, share technical knowledge, and ensure that the ARRA technologies are properly coordinated and applied throughout the state.

Successfully awarded ARRA projects encompass technologies from electricity generation level to end-use applications. Technologies include the following:

- Smart meters
- Electric vehicle charging stations

- Energy storage technologies including flywheels, lithium-ion batteries, zinc-chloride batteries, reduction-oxidation flow batteries, and underground compressed air
- Cybersecurity
- Synchrophasors for electric transmission lines
- Renewable energy generation
- High penetration solar deployment
- Geothermal drilling
- Carbon sequestration (capture and storage)
- Energy efficient building technologies
- Workforce training development

These ARRA-funded projects will affect all areas of California's electric system. With the help of the Energy Commission, these ARRA projects will lay the foundation for California's 21st century clean energy economy and accelerates investment in infrastructure.

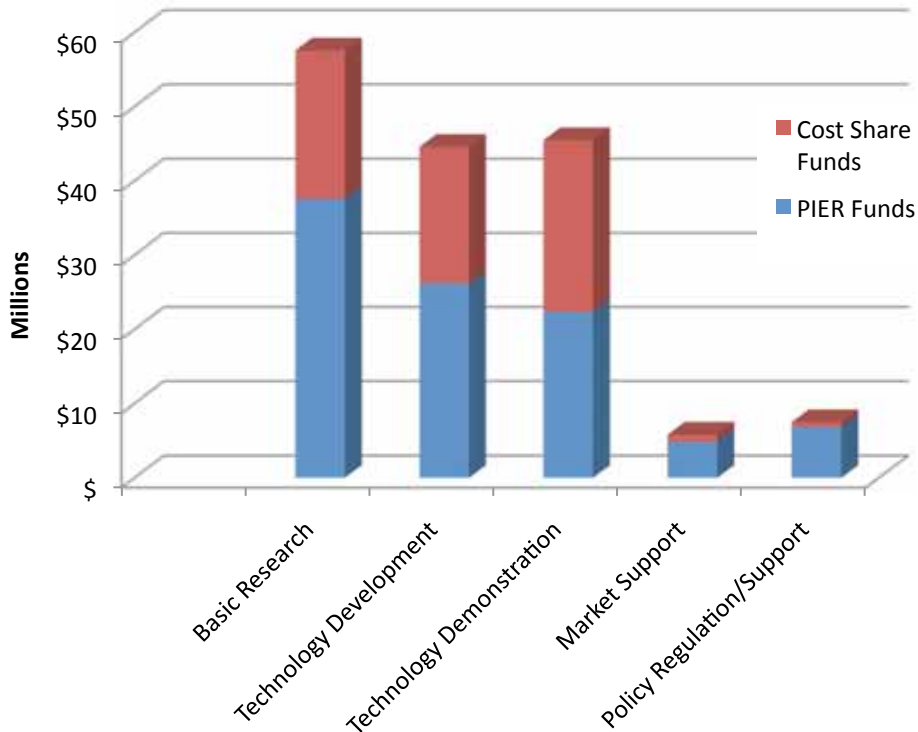
Leveraging Cost Share Investments

Commission-funded projects receive cost-share funding from various stakeholders. When prioritizing the state's research investment decisions, the Commission considers how cost-sharing opportunities can maximize our research portfolio, as well as demonstrate the commitment of the research organization to achieve success.

The Commission's RD&D moves concepts from the basic research phase to eventual market commercialization. The process involves a great many investment steps along the way, often takes many years, and is inherently risky, with no guaranteed outcomes. The Commission developed a phased approach to help reduce the inherent risks of research. The Commission evaluates results at each stage and assesses the risks and benefits before committing to the next stage.

The Commission developed the following research stages: basic research, technology development, technology demonstration, market support, and policy and regulation support. Figure 5 shows PIER's project and partner cost-share funding for 2009 according to research stage.

Figure 5: 2009 PIER Project and Partner Cost-Share Funding by Research Stage



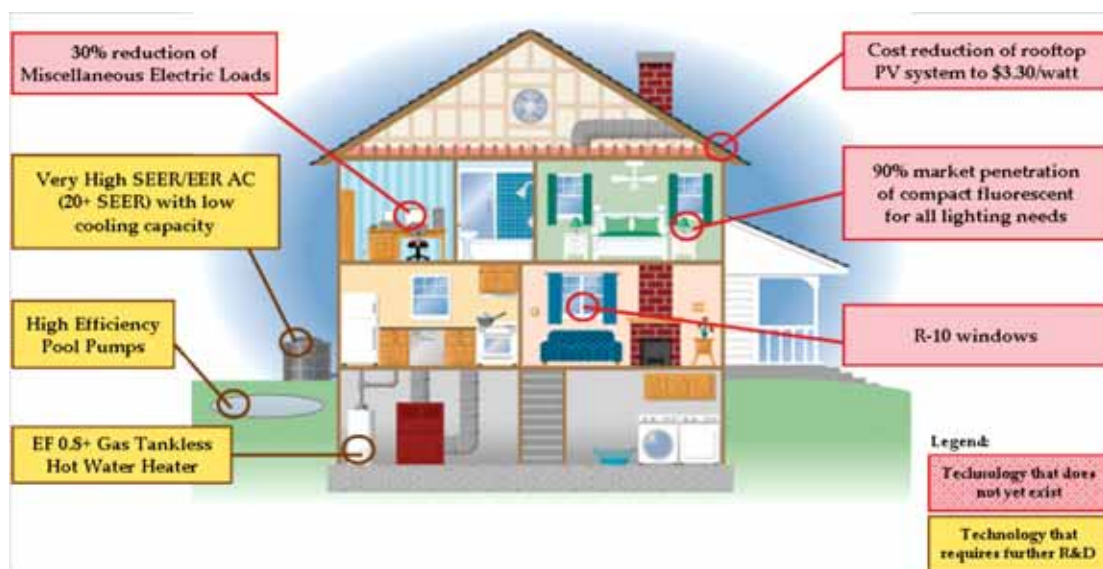
Source: California Energy Commission

The West Coast Regional Carbon Sequestration Partnership (WESTCARB) is an example where the Energy Commission PIER Program is substantially leveraging federal and industry funding and bringing technology and jobs to California. WESTCARB's goal is to characterize regional carbon capture and storage (CCS) opportunities and conduct technology validation field tests. For the three phases of the WESTCARB program – a research program that will span more than 10 years – the PIER Program is able to leverage an investment of less than \$10 million in state funds and bring more than \$110 million to California and the western state partners.

Leveraging Funds within the PIER Program

The Commission's primary RD&D funding sources for the PIER Program are the \$62.5 million electricity research funds authorized by SB 1250 and the \$24 million natural gas surcharge funds authorized by the California Public Utilities Commission (CPUC). This joint program management is critical to determine overlapping impacts between electric research and natural gas research projects and apply lessons learned across both types of projects. California relies on natural gas to generate nearly half of its electricity. Consequently, reductions in electricity consumption result in natural gas savings, which increases overall energy efficiency. Figure 6 illustrates the synergistic relationship between electricity research and natural gas research currently supported by the Commission.

Figure 6: Electricity and Natural Gas Technologies in Need of RD&D



Source: California Energy Commission

Leveraging Expertise within the State

California is proud of its high-tech heritage. To maintain its high-tech leadership, the Commission attracts expertise to California through centers of excellence, partnerships, working groups, and by funding entrepreneurs and scientists.

Engage the Research Community through Centers of Excellence

The Commission found that funding technology research centers through the PIER program is one of the best ways to target research on technologies most needed to advance evolving energy policies, and is a cost-effective method to bring together industry and manufacturing experts. Through these centers, experts develop design analysis tools, prepare monitoring and characterization studies, and conduct research on advanced components, systems, and technologies to reduce energy use and electrical loads. The PIER Program attracts recognized industrial experts from private industry, universities, and national labs to compete for research opportunities.

The Commission created or supported the following unique research centers in California:

- California Climate Change Research Center
- Smart Grid Center
- Demand Response Research Center
- Center for Resource Efficient Communities
- Center for the Built Environment
- California Hybrid, Efficient, and Advanced Truck Research Center
- Plug-in Hybrid Electric Vehicle Research Center
- California Lighting Technology Center
- Western Cooling Efficiency Center
- California Advanced Lighting Controls Training Program (CALCTP)

California Climate Change Research Center

The Commission developed a long-term climate change research plan and created the California Climate Change Research Center. The center is based at several universities (for example, Scripps Institution of Oceanography, Stanford, and UC campuses), research institutions, and national laboratories throughout California. Its main objectives are to develop tools and information needed to identify how climate change affects energy supply and demand in California, develop plausible climate change scenarios for California, understand how the physical impact of climate change would affect California's environment and economy, and analyze the merits of different mitigation and adaptation strategies that would particularly affect California. A product of the center's research, "*The Future is Now: An Update on Climate Change Science Impacts and Response Options for California*" (CEC-500-2008-071), prompted the Governor to announce a comprehensive Climate Adaptation Strategy for California. The Commission will participate in this strategy by preparing a Climate Vulnerability study.

Smart Grid Center

In late 2009, the Energy Commission established a center for smart grid research at the California State University, Sacramento (CSU Sacramento). This center will perform research on home area network technology, utility equipment testing and development, smart grid interoperability standards, cybersecurity, and the coordination of smart grid workforce development activities. The Smart Grid Center will coordinate developed technologies from other research centers of excellence for integrated demonstrations and testing under a smart grid framework. The various centers will work on aspects of the smart grid, and bring these technologies to CSU Sacramento or other locations for integrated demonstrations and testing. As the center moves forward, it will work with utilities, other universities, engineers, operators, and other research organizations to provide guidance and training.

Demand Response Research Center

Lawrence Berkeley National Laboratory (LBNL) facilitates the Demand Response Research Center (DRRC) by guiding project development and providing technical, operational, and planning leadership to help develop demand response markets. During 2009, the DRRC was able to support the nationwide adoption of the automated demand response technology that was field tested by the Energy Commission, California utilities, and the DRRC. The field demonstrations established that commercial and industrial businesses, using an automated process such as Open Auto-DR, could reduce electric demand by an average of 8-10 percent during times of high electricity use.

The National Institute of Standards and Technologies (NIST) is developing and coordinating national standards for smart grid. In 2009, the Open Automated Demand Response (Open Auto-DR) standard – researched, tested, and implemented by the DRRC – was selected as one of the national smart grid standards by NIST. Open standards will allow product innovation in

demand response technologies, similar to what we experience in the internet and computer arena, by giving industry a clear technical platform for their products and services. This standard evolved from more than seven years of research and field demonstrations funded by the Energy Commission and California utilities. Open Auto-DR is available in more than 30 commercial products.

Center for Resource Efficient Communities

In 2009, the Commission funded the College of Environmental Design at UC Berkeley to create the Center for Resource Efficient Communities (CREC). The center performs interdisciplinary research, public communication, and professional outreach to support the state's climate change and resource efficiency goals. The center creates tools and standards to improve planning, design, and operation of communities to make them more resource efficient. One example is designing communities that increase walking or bicycling as a substitute for car use.

CREC will identify the best strategies in the development of resource efficient communities, and inform local government planning agencies, developers, and others who must meet the challenges of AB 32 and SB 375, which set targets for greenhouse gas reductions stemming from land use patterns and community design. The center has already established working relationships with the Fisher Center for Real Estate and Urban Economics in the Haas School of Business (UC Berkeley); the Center for Law, Energy, and the Environment at Boalt Hall School of Law (UC Berkeley); and the Center for Sustainable Transportation (UC Davis).

Center for the Built Environment

The Center for the Built Environment's (CBE) primary objective is to improve the energy efficiency, design, operation, and environmental quality of buildings by providing timely, unbiased information on building technologies, design techniques, and feedback on functional building performance.

The CBE, located at UC Berkeley, conducts behavioral studies and researches new technologies that create a more productive work environment, increase energy efficiency, and reduce the environmental impacts of buildings during construction and operation. As a result of Commission funded research on thermal comfort, the center is updating the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) thermal comfort standard. This research is valuable for manufacturers who target their building products to partners who manage, operate, and design buildings.

Industry partners include: Armstrong World Industries, Arup, Charles M. Salter Associates, Incorporated, Cohos Evamy Integrated Design, Coherent Structures, DPR Construction, EHDD Architecture, Environmental Systems Design, Glumac, Haworth, HOK, Kling Stubbins, Larson Binkley, Pacific Gas and Electric Company, Price Industries, Rumsey Engineers, Cermak, Peterka, Petersen, Incorporated, Mahlum Architects, Mithun, Perkins+Will, Skidmore, Owings and Merrill, LLP, Southern California Edison, Steelcase, Incorporated, Syska Hennessy Group, Tate Access Floors, Taylor Engineering, CTG Energetics, Guttman and Blaevot, Sutherland Industries, Swinterton Builders, U. S. Department of Energy, U.S. General Services Administration, Webcor Builders, WSP Flack + Kurtz, and Zimmer Gunsul Frasca Architects.

California Hybrid, Efficient, and Advanced Truck Research Center

The California High Efficiency Advanced Truck Research Center (CalHEAT) in Pasadena will research and deploy technologies that increase use of alternative fuels and reduce the impact of emissions near ports and major transportation corridors. The primary goal of the CalHEAT research center is to lead a research, development, and market transformation process that accelerates the commercial deployment of high-efficiency truck and goods movement technology, focusing on California's medium- and heavy-duty transportation needs.

The center will bring engine and truck manufacturers together with fleet operators to identify and co-fund proof of concept technologies. Research includes demonstrating successful electric hybrid configurations with a variety of fuels to stimulate introduction of more efficient trucks and buses into early market niches, such as port trucks (drayage carriers), beverage and package delivery trucks, refuse trucks, transit buses, and utility trucks. Successful demonstrations of electric hybrid prototypes requiring total investment of \$20 million to \$30 million per year over five years will lead several truck and engine manufacturers to develop early market models. Assembly line production will need to achieve sales of 3,000-5,000 units per year to be cost-competitive with conventional diesel trucks.

Trucks and goods movement are critical to the state's economy, yet remain a real and growing energy and carbon challenge that has not been sufficiently addressed in research. Medium- and heavy-duty vehicles consume more than 18 percent of the total fuel used in California's vehicle fleet, about 3.7 million gallons annually, and emit greenhouse gasses proportional to that fuel consumption. Figure 7 shows lines of trucks with engines idling in one of the busiest California ports.

Figure 7: Trucks Idling at the Port of Los Angeles



Photo Credit: Port of Los Angeles

The challenge is particularly visible in Southern California, the state's – and, arguably, the nation's – biggest transportation hub. Heavy on-road traffic serving goods movements combined with off-road vehicle use at distribution centers and ports result in poor regional air quality and a significant source of greenhouse gas emissions in the Ports of Los Angeles and Long Beach, where more than 40 percent of all containerized trade in the nation funnels into distribution channels.

Plug-In Hybrid Electric Vehicle Research Center

Plug-in hybrid and electric vehicles (PHEVs and EVs) are promising and potentially revolutionary keys to improve California's economy. Fueling vehicles using grid electricity stored in on-board batteries, PHEVs' potential vehicle efficiency can reach 90 miles per gallon or more, which is about four times today's average vehicle efficiency. EVs use no petroleum at all. How PHEVs & EVs will be integrated into the emerging smart grid system is a long-term research interest because of complexities in the grid's ability to accept such distributed loads.

The Plug-in Hybrid Electric Vehicle Research Center's goals are to provide technology and policy guidance to the state and to help solve research questions and address commercialization issues for PHEVs & EVs. The center, located at UC Davis, coordinates with existing research organizations, including the South Coast Air Quality Management District, Nissan, Ford, Chrysler, General Motors, Electric Power Research Institute, U.S. Department of Energy, Southern California Edison, PG&E, and other California utilities.

California Lighting Technology Center

A collaboration between the Energy Commission, the U.S. Department of Energy, and the National Electrical Manufacturers Association developed the California Lighting Technology Center (CLTC) at the University of California, Davis. CLTC's goal is to stimulate, facilitate, and accelerate the development and commercialization of energy-efficient lighting and daylighting technologies. The CLTC distributes information about the technologies to accelerate marketplace connections, including informing the building and lighting industry, research communities, design professionals, lighting installers and maintenance professionals and decision makers.

Future Commission-funded research projects include high-efficiency bi-level smart wall packs, LED/Induction exterior lighting, demand-responsive ambient lighting, and best practices manuals for the Department of General Services.

Currently there are 47 industrial partners, including the major California electric utilities, Chevron, Acuity Brands, 3M, Walmart, CREE, Osram Sylvania, WattStopper, Day-Brite-Capri-Omega, Tyco Electronics, Gardco Lighting, Echelon, Finelite, Convia, National Semiconductor, Metrolight, LGP, Philips Lumileds, Full Spectrum Solutions, Catalonia Institute for Energy Research, RUUD Lighting, HID Laboratories, Inc., ADURA technologies, LED ERA, Inc., Deco Lighting, Eskaton Senior Residences and Services, Lightech, MaxLite, Ambient, Novicomm, Intematix, Encelium, Topanga Technologies, AECOM, Lutron, Convergence Wireless, OptoElectronix, B-K TEKA Lighting Illumination, Progress Lighting, LUXIM, InteLED, Lunera, SHARP, Evluma, and Orion.

Western Cooling Efficiency Center

The Western Cooling Efficiency Center's (WCEC) goal is to identify technologies, disseminate information, and implement programs that reduce cooling system electrical demand and energy consumption. The WCEC, located at UC Davis, conducts research that confronts market barriers by developing strategies to overcome market impediments for energy-saving cooling systems. It will support technology development projects that can cost-effectively reduce cooling system energy use and peak demand in California. WCEC offices are designed to function as working laboratories, allowing partners and affiliates to display and demonstrate emerging cooling technologies. Several completed projects showed the potential to reduce cooling energy consumption in California buildings by 50 to 90 percent with improved equipment compared to conventional systems.

The WCEC focuses on technologies that are well suited to dry western climates, particularly those overlooked in current markets, such as evaporative coolers including water management, radiant cooling, and vapor compression. Future research will focus on zero-peak cooling systems, low cost large chilled water storage systems, optimized hybrid cooling systems, optimization of heat and mass transfer from surfaces, and condenser air pre-cooling.

Industry partners include the major California electric utilities, Beutler Corporation, Coolerado Corporation, Davis Energy Group, ICE Energy, Integrated Comfort, Incorporated, Lennox International, Munters, NovaTorque, Incorporated, Seeley International, Speakman Company, Timmons Design Engineers, Trane, United Metal Products, Uponor, Viega, VRTX Technologies and Walmart.

California Advanced Lighting Controls Training Program

The California Advanced Lighting Controls Training Program (CALCTP) promotes the proper design, installation, commissioning, and maintenance of advanced lighting control systems through training and certification of contractors. The CALCTP team is composed of International Brotherhood of Electrical Workers (IBEW) Journeyman Apprentice Training Centers, contractor and labor organizations, the California Community College system, lighting control manufacturers, the California Lighting Technology Center at UC Davis, California electric utilities, ICF International, and the Energy Commission.

CALCTP developed a curriculum to provide labor and trade organizations with a high-value training opportunity for its members. This consortium is currently applying for a U.S. Department of Labor Energy Training Partnership Grant of between \$2 million and \$5 million. Under this proposed grant, CALCTP would collaborate with the California Community College system to expand and strengthen the statewide network to create new training opportunities and create new, clean energy jobs for individuals interested in the high efficiency advanced lighting field.

Collaborations

The Commission maintains collaborations with state and national agencies with common interests. The Commission works with its sister state agencies – including the CPUC, California Air Resources Board, Environmental Protection Agency, Department of Fish and Game, and the Department of Water Resources – to coordinate research efforts and fulfill policy goals. The University of California and the California State University systems are an integral part of conducting specialized research. The Commission also works with a number of federally funded national labs that provide access to a community of researchers that transfer information beyond the state level. In addition, the Commission works with the U.S. DOE to increase funding opportunities for valuable research projects.

West Coast Regional Carbon Sequestration Partnership (WESTCARB)

The Commission manages the WESTCARB partnership, one of seven regional partnerships funded by the U.S. DOE. The partnership consists of more than 80 organizations. WESTCARB's goal is to characterize regional carbon capture and storage (CCS) opportunities and conduct technology validation field tests. Carbon dioxide accumulates in the atmosphere before being removed by natural processes, therefore slowing and ultimately reversing atmospheric carbon dioxide buildup will require deep reductions in man-made carbon dioxide emissions. CCS is one method to reduce these emissions. Carbon dioxide captured at industrial facilities needs to be stored in a location where it will not escape to the atmosphere or interfere with human activities and the environment.

California Renewable Energy Collaboratives

The Energy Commission funds four renewable energy collaboratives: the California Biomass Collaborative, the California Wind Energy Collaborative, the California Geothermal Energy Collaborative, and the California Solar Energy Collaborative. The Commission funds planning for joint efforts among these organizations, including a research program on integrated renewable energy systems.

These collaboratives are statewide networks of government, industry, environmental groups, and educational institutions. They have two primary missions: 1) Provide a venue for technical information exchange and coordination among, industry, government, utility, and academic research stakeholders; and 2) Conduct early stage research that feeds forward to PIER's renewable energy development and demonstration projects. Collaborative research agendas will increasingly favor projects that address the integration challenges of PIER's development and demonstration programs in utility-scale renewable energy, renewable energy secure communities, and renewable energy secure buildings.

For example, the California Wind Energy Collaborative identified a strategic opportunity related to wind energy applications in California's agricultural sector. In cooperation with the California Solar Collaborative, the California Wind Energy Collaborative is undertaking new projects addressing resource and power plant production forecasting in cooperation with the California ISO. The California Biomass Collaborative (CBC) is leading the efforts to accurately assess biomass feedstock availability for power generation and fuel production, while also leading efforts to properly account for "net benefits" of bio-energy deployment in California. The CBC also initiated efforts in support of the Commission's effort to update the state's Bioenergy Action Plan.

The California Solar Collaborative will provide technical leadership regarding the development and deployment of solar cooling technology and other solar thermal solar applications in

California as well as solar photovoltaic deployment targets of the California Solar Initiative. The California Geothermal Collaborative is technically supporting ground source heat pump deployment in California, upgrading California geothermal resource databases, and developing a more geographically and technically diverse range of geothermal exploration.

CHAPTER 3:

Advancing Energy Technologies in 2009

At the forefront of energy research for more than 11 years, the Commission supports research that provides tangible benefits to California. By focusing its research on the most promising, new, and emerging technologies, California will remain at the forefront of technological innovation. Given the nature of RD&D projects, a research project often takes many years to move from initial concept to market-ready technologies. Some of the first electricity research projects have now come to fruition, and a broad spectrum of consumers use those products and technologies, generating savings for California ratepayers.

In 2009, the Commission funded projects that bring potentially groundbreaking technology to California. Illustrated below are examples of promising projects covering the following topics: climate change, smart grid, renewable resource integration, advanced transportation and fuel technologies, efficient offices, zero net energy homes, carbon capture and storage, and Energy Innovations Small Grants.

Google Earth Displays Climate Change Impacts

Climate change researchers have been searching for ways to convey the risk posed by climate change to a wider audience. Researchers have also had difficulty relaying relevant information to decision makers who can establish effective climate change adaptation decisions and policies. For these reasons, the Commission and Google co-funded the Stockholm Environmental Institute to develop a Google Earth application that can display projected climate change impacts, including climate projections for the 21st century, electricity demand, and potential changes in wildfire risks. On December 2, 2009, the Governor unveiled the prototype CalAdapt website (<http://www.climatechange.ca.gov/visualization/index.html>). This application is an early prototype product that will be enhanced in the future. Figure 8 shows one of the maps that can be viewed on the CalAdapt website.

Figure 8: Sea Level Projections



Sea level projections using Google Earth (www.climatechange.ca.gov/visualization/sealevel.html)
Photo Credit: California Energy Commission

California Climate Change Research Center

A Commission priority is to reduce greenhouse gas emissions from energy use. The Commission is working with the California Climate Change Research Center in developing climate monitoring, analysis, and modeling to understand how and why energy use affects climate change in California. Improving greenhouse gas inventory methods is also necessary, as current estimates for greenhouse gas emissions are highly unreliable, especially for methane, nitrous oxide, and other non-carbon dioxide greenhouse gases. Research in this area entails improving key methods for estimating emissions so California can accurately track emissions trends.

The research results identify options to reduce greenhouse gas emissions, and weigh the relative costs and benefits of each option. The work focuses on studying the impacts of – and adaptation to – climate change on different sectors of the economy, such as energy, water, and human health.

Smart Grid

The wide variety of smart grid technologies being demonstrated in the ARRA-funded research projects shows the commitment California has made toward implementing one integrated smart grid across the state. The Commission is taking an active role to ensure a unified smart grid for California that integrates all energy technologies and improves electric system

reliability. The smart grid will also allow California ratepayers to make choices regarding their energy use. In addition to these ARRA projects, the Commission has funded other projects contributing to a comprehensive smart grid, including microgrid demonstrations, integrated energy storage and distributed renewable generation systems, automated demand response technologies, and advanced cybersecurity measures.

Microgrids and Distributed Energy Resources

The smart grid of the future can be demonstrated and implemented through the use of regional and local smart microgrids. Microgrids are modern, small-scale versions of the centralized electricity system. Microgrids are an innovative approach to migrating California's distribution system to the next generation where distributed generation and storage resources are integrated with demand response into one coordinated energy system. Like the bulk power grid, smart microgrids generate, distribute, and regulate the flow of electricity to consumers, but do so locally. Smart microgrids are an ideal way to integrate renewable resources on the community level and allow for customer participation in the electricity marketplace. Microgrids can address many of California's growing utility grid challenges, including the integration of large amounts of renewable energy resources, grid congestion relief, and more reliable and efficient grid operations.

Sacramento Municipal Utility District Microgrid Demonstration

The Commission provided more than \$1.5 million to the Sacramento Municipal Utility District (SMUD) to demonstrate and validate the technologies developed under the Commission-funded Microgrid Laboratory Test Bed by the Consortium for Electric Reliability Technology Solutions (CERTS). The SMUD microgrid will demonstrate the integration of distributed generation, renewable technologies, combined heat and power systems, and energy storage. SMUD hopes to demonstrate that the microgrid can successfully separate from the utility system and provide reliable power. This project will demonstrate several of the key smart grid elements defined in the Energy Independence and Security Act of 2007 and help California utilities and regulators define and implement the future Smart Grid in California.

CERTS Smart Grid Demonstration of Renewable Resources and Large-Scale Energy Storage Integrated at Santa Rita Jail, Alameda County, California

Alameda County received a U.S. DOE grant and an Energy Commission grant for a smart grid demonstration involving wind, solar thermal, and large-scale energy storage integration at the Santa Rita Jail. This demonstration will integrate CERTS-compatible components to create a real-life working model for renewable energy integration in a high-demand, 24-hour/7-day operating community with a 4500-inmate capacity. Overproduction from the on-site renewable electrical systems will be stored in a new 2-megawatt, nearby sodium sulfur (NaS) battery system. This battery storage system will reduce the jail's electric demand during the summer peak periods to zero, and give the jail the ability to export energy when needed. Energy exporting capability is important to the PG&E to reduce congestion and reliability problems on the local distribution grid.

Enabling Renewable Energy, Energy Storage, Demand Response and Energy Efficiency with a Community-Based Master Controller-Optimizer

The Commission provided \$1 million in funding to UC San Diego to demonstrate a semi-autonomous smart grid controller that manages a community-scale smart grid. The controller will use real-time power system analytics to capitalize on the campus assets, which include advanced metering infrastructure, communication network, installed renewable energy generation, and thermal and electric storage. A fully functional smart grid master controller that optimally schedules renewable energy resources, energy storage, and energy efficiency

measures including demand response is essential for communities to operate intelligently with the greater grid.

Advanced Residential Energy and Behavior Analysis Project

In July 2009, the Commission provided \$1.2 million to Portland State University in Oregon to analyze data on residential natural gas and electricity use and efficiency choice. This data will improve California's understanding of the changing landscape of residential consumption and develop next-generation models to support effective carbon-reduction policies and programs.

ARRA and Open Automated Demand Response

Several ARRA grant recipients, including Honeywell and SMUD, are implementing Open Automated Demand Response (Open Auto-DR) standards, developed by the Demand Response Research Center, in their large-scale smart grid demonstration projects. Honeywell Utility Solutions will install 80 megawatts of demand response capability in the SCE service territory using Open Auto-DR technology, doubling the currently installed capability. This project could spur implementation of this Commission-funded, open source protocol among other utilities and large control companies. Most importantly, from the commercial and industrial customers' perspectives, automated demand response gives these customers the means to respond automatically to price signals from the utility. This automated response capability is expected to provide a positive financial impact for customers with the large-scale rollout of critical peak pricing in 2010. The electric system will be more resilient and result in lower system costs by using automated reduction in customer load during peak demand times.

Automated Demand Response in Large Facilities

The Commission funds the Demand Response Research Center to explore the development and field-testing of fully automated demand response technologies for large commercial, institutional, and industrial facilities. Open Auto-DR is currently deployed in more than 200 facilities in California totaling more than 80 megawatts of capacity and is one of the 16 initial smart grid interoperability standards recognized by the National Institute of Standards and Technology (NIST).

Cybersecurity

Since September 11, 2001, there has been a concerted effort in both the public and private sectors to improve the security of critical infrastructure. To address the security of California's electricity infrastructure, the Commission created the PIER Security Research Program in 2004 in response to the Governor's Executive Order D-67-03⁴. The Commission is dedicated to ensuring a robust, secure, and reliable energy infrastructure for California through its research efforts. The Smart Grid Center includes cybersecurity as one of its core areas of expertise and the Commission will continue to explore the cybersecurity needs of California and the future California Smart Grid through this center.

Renewable Resource Integration

Renewable resources are essential for reducing greenhouse gas emissions and reaching state energy goals. The state's energy priorities for new energy resources puts renewable

⁴ Executive Order D-67-03 calls upon state departments and agencies to assist the Office of Homeland Security and the Director of the Office of Homeland Security in developing and coordinating the implementation of a comprehensive state strategy to coordinate security activities throughout California.

technologies second only to efficiency and demand response technologies as the preferred resources to meet California's growing energy needs. Already more than 11 percent of the electricity delivered to California homes and businesses is obtained from renewable energy sources. To continue working toward the state's energy goals, the PIER Program shifted its focus from individual technologies to accelerating the deployment of multiple renewable energy conversion technologies.

In April 2009, the Commission announced awards for Renewable-based Energy Secure Communities (RESCO). These projects focus on community solutions, renewable energy sources, and conversion technologies over a large geographic area. The RESCO approach will help deploy synergistic demonstration projects in California that provide innovative integration solutions and capabilities for a portfolio of local renewable energy and efficiency measures.

RESCO advances science and technology by developing and demonstrating mixed renewable technologies in an integrated, sustainable, and optimum manner to ensure that communities secure their electricity and fuel supply through primary reliance on renewable resources. Moreover, RESCO integrates and capitalizes on recent and on-going advancements in energy efficiency and demand response, smart grid technology, combined cooling heating and power (CCHP), energy storage, and co-production of transportation fuels.

UC Davis West Village Zero Net Energy Community

The West Village Renewable-Based Energy Secure Community located at UC Davis will provide 3,000 residents with affordable, reliable, and secure energy. A goal of the West Village project is to be a zero net energy (ZNE) community. This means the West Village will satisfy its annual electricity and gas demand by utilizing on-site renewable resources. It will be a model for future communities and help accelerate the adoption and use of scalable renewable energy systems in California. The project will break ground in 2010. Figure 9 shows a sketch of the future community.

Figure 9: UC Davis West Village



Artist sketch of West Village site containing a Village Square and 45,000 square feet of retail space and apartment units.
Photo Credit: University of California, Davis

Renewable Energy Secure Sonoma County

In June 2009, the Commission provided \$1 million in funding to the Sonoma County Water Agency to demonstrate a model for the integration of mature renewable resources and conversion technologies coupled with efficiency measures and demand response. This model will prepare Sonoma County for constructing a locally owned, cost-effective renewable energy portfolio. Other key participants include the Los Alamos National Laboratory, the Climate Protection Campaign, Local Power, and the Sonoma County Transportation Agency.

Sonoma County pledged to reduce carbon emissions by 25 percent below the 1990 levels by 2015. Throughout the project, the county will develop tools and methods to design a low-carbon portfolio, develop implementation strategies, and implement a pilot project. The pilot project will take place at Santa Rosa Airport's Wastewater Treatment Plant (WWTP) and demonstrate the following features:

- A geothermal heat pump system using treated wastewater to reduce heating and cooling costs.
- A solar photovoltaic system with a peak output of 500 kilowatts and a 10-kilowatt wind turbine to power both the WWTP and electrical vehicle charging stations.
- An anaerobic digester using manure from surrounding dairies to produce biogas that will power a 10-kilowatt output fuel cell.
- Buildings retrofit and conservation measures to maximize energy efficiency.
- A Web-based integration model to evaluate specific renewable energy portfolios that will meet electrical demand across county sectors and reduce carbon dioxide emissions.

Technology Innovations for Buildings and Communities II

In April 2009, the Commission used an integrated research approach in the Technology Innovations for Buildings and Communities II (TIBC) solicitation to bring together a team of individuals with administrative, research, and market expertise. An integrated research program proposal consists of a collection of closely linked RD&D projects that address related issues or research and market needs within a single proposal under an overall prime contractor program director. These proposals integrate renewable energy, land use, and building efficiency. One of the key objectives of the TIBC solicitation is to support RD&D that informs future revisions of the California Building Energy Code (Title 24) and ensures that the building standards incorporate cost-effective energy efficiency measures. Research projects recommended for funding involve energy efficiency in existing homes, multi-family, and multi-tenant commercial buildings; food service appliances, consumer electronics, and development of tools for computer based energy efficiency training.

Drilling for Geothermal Energy

The Commission administers the Geothermal Research Development Account (GRDA). In November 2009, the Commission funded the Canby Geothermal Development Project in Modoc County.

This project will create the first completely sustainable zero net energy community in California by fully cascading a geothermal resource to produce renewable electrical power for California ratepayers, and create jobs by implementing several geothermal direct-use applications that include greenhouse and aquaculture operations.

The project will re-inject water from the geothermal wells back into the well instead of discharging it into the nearest river. This approach will increase the capacity of a district heating system, thereby allowing additional uses. This project is located in a small population center that can take advantage of the developing geothermal resource.

Planning for Wind Energy

A previous Commission research project had a notable success in 2009. The Imperial Valley and Tehachapi Implementation Groups used the Commission's *Intermittency Analysis Project: Summary of Final Results (IAP)* report on wind energy to develop transmission plans for delivering an additional 6,500 MW of renewable power to the electricity grid.

The California ISO also used this report as the starting point for its *Integration of Renewable Resources Report* to identify issues and solutions for integrating large amounts of renewable resources into the California ISO control area.

Similar studies performed in other regions of the country used the methods in the *IAP*, including the *Eastern Wind Integration and Transmission Study* and the *Analysis of Wind Generation Impact on Electric Reliability Council of Texas (ERCOT) Ancillary Services Requirements*. The Hawaiian Electric Company modeled its ongoing Clean Energy Scenario planning process based on the methods developed for the *IAP*.

Personal Air Conditioning in Vehicles

California vehicles annually consume approximately 470 million gallons of gasoline for occupant cooling in light-duty vehicles resulting in annual releases of approximately 4 million metric tons of carbon dioxide into the atmosphere. Approximately 30,000 tons of R-134A, a global warming refrigerant contained in the 30 million registered vehicles in California, can potentially cause severe environmental damage if not safely managed. Many European nations will be instituting bans on the use of R-134A in the near future, and the United States – including the California Air Resources Board – is expected to follow suit.

In June 2009, as a solution to eliminating cooling refrigerant in vehicles, the Commission funded a project with the National Energy Technology Laboratory to develop and demonstrate an advanced, operational, and economically viable thermoelectric HVAC system. Using thermoelectric technology, airflow in a vehicle is directed to its occupants, which in California is typically a single occupant, instead of the entire cabin as a whole. Figure 10 is an illustration of air flow directed at vehicle occupants.

Figure 10: Air Flow to Vehicle Occupants



Illustration of Thermoelectric Air Conditioning
Photo Credit: U.S. Department of Energy

Thermoelectric devices convert electrical energy to temperature differences (heat and cold), producing a more energy-efficient air conditioning and heating system by not requiring the use of global warming refrigerants and minimizing or eliminating the current vapor compression air conditioner in automobiles. This project's objective is to demonstrate a 33 percent reduction

in HVAC energy requirements, which represents 155 million gallons of fuel annually, equivalent to 1.3 million metric tons of carbon dioxide for all of California's light duty vehicles.

Educating for Advanced Meters

The Energy Commission, in cooperation with the Coachella Valley Water Agency and equipment suppliers, developed a report that describes the factors motivating the change from traditional water meters to automatic meter reading (AMR) and advanced metering infrastructure (AMI) systems. California water agencies are interested in these technologies, with 75 percent of them planning on evaluating and/or installing automatic meter reading or advanced meter infrastructure systems in the near future. This report titled *Smart Meters and California Water Agencies Overview and Status* (CEC-500-2010-008), provides information to California-based water agencies on the best options for water meter technology. AMR and AMI systems are fundamental to smart grid implementation, without which demand response and dynamic pricing programs would not be possible.

Smart Offices

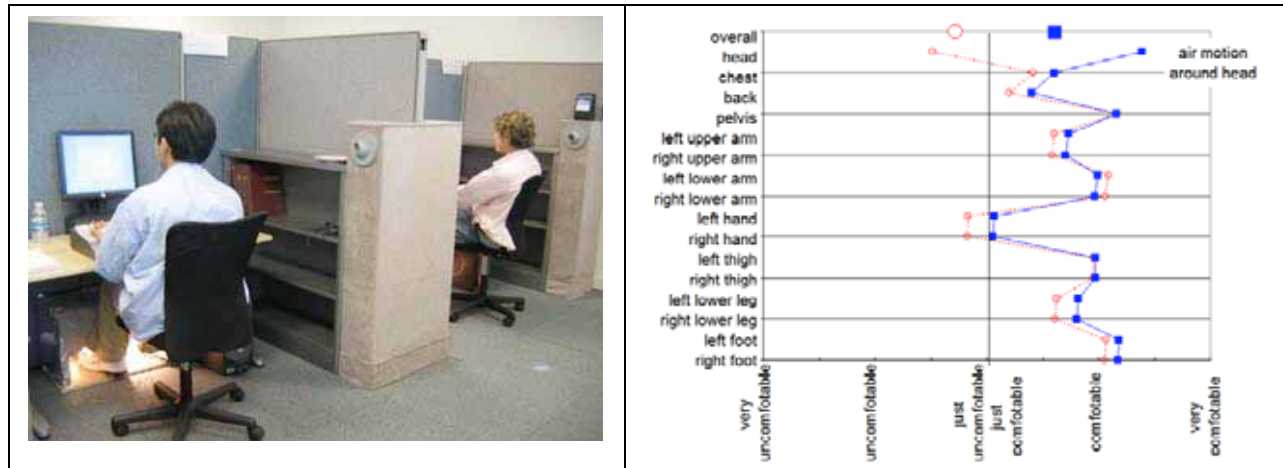
Several projects in 2009 focused on energy efficiency and human convenience in the workplace. Common office equipment – such as printers, copy machines, network servers, cell phone chargers, and other miscellaneous plug loads – are one of the fastest growing electricity consumers in California offices. Human behavior, however, also determines energy use in an office environment. PIER research includes projects studying how California can more efficiently use our energy for comfort and convenience by eliminating unnecessary energy consumption in HVAC systems and office equipment, and by increasing efficiency in windows and lighting.

Thermal Comfort Studies Yield Energy Savings

In 2009, Commission-funded researchers at the UC Berkeley Center for the Built Environment (CBE) learned that the Danish Technical University was proposing a standard stating that first-class indoor environments should have virtually no air movement. The CBE researchers recognized that they had data showing otherwise.

CBE conducted a Commission-funded study several years ago to determine how people perceive thermal comfort. The researchers collected volunteer responses to various air temperatures and velocities to understand what actually constitutes thermal comfort. Figure 11 shows one of the office test sites and a sample of the thermal comfort results.

Figure 11: Thermal Comfort in Offices



Thermal Comfort Testing with Head Cooling Towers and Sample Results of Thermal Comfort Survey
Photo Credit: Center for the Built Environment

The research data revealed that people are just as comfortable with somewhat warmer temperatures when there is air movement. Giving occupants individual control over their environment produced the highest satisfaction of all. Armed with this Commission-funded knowledge, the CBE researchers argued against the proposed thermal comfort standard, and without supporting data, the proposed standard was eventually withdrawn.

The researchers are providing an update to the thermal comfort standards for ASHRAE Standard 55 to give low-energy consumption spaces a first-class rating, the highest level of comfort and thermal acceptability to occupants. In addition, they are developing small appliances to provide individual control over personal spaces. Major office furniture makers are working to bring these new solutions to market. Use of these devices help achieve zero net energy commercial buildings, minimizing the need for air conditioning.

Smart Plug Strips Reduce Unnecessary Power Consumption

Consumer electronics, office equipment, and other plug-in devices consume 15 to 20 percent of total residential and commercial electricity in the United States. These devices continue to consume energy, even when not actually in use, as they continue to operate in low-power or standby modes. One way to reduce this unnecessary electricity consumption is to use smart plug strips.

Smart plug strips employ a combination of load sensors, remote controls, occupancy sensors, or timers, or Universal Serial Bus (USB) interfaces that automatically disconnect power to plug-in devices when they are not in use. Most smart plugs strip have one “master” control outlet, four to six controlled outlets that will automatically power down designated devices, and one or two uncontrolled outlets that are always on.

By automatically turning off plug loads when not in use, smart plug strips can save energy in residential and commercial sectors. Applications for smart plug strips include computer workstations, open office cubicles, home offices, and home entertainment systems. For many applications, smart plug strip manufacturers claim payback periods of less than two years. However, very limited, independent, objective, and detailed research is available on these devices. Figure 12 shows various types of smart plug strips.

Figure 12: Smart Plug Strips



Photo Credit: Ecos

In July 2009, the Commission funded research to evaluate the smart plug strips that are currently on the market and to determine the potential energy savings associated with their use. The project involved laboratory and field studies to evaluate the performance and standby power of selected smart plug strips then compared this data with previous measurements and market research. Preliminary research showed that one smart plug strip used with office equipment such as computers, monitors, and printers could save from 25 kWh to 180 kWh per year per household or office. When used with home entertainment equipment such as TVs, DVD players, and amplifiers, one smart plug strip can save from 25 kWh to more than 100 kWh per year.

Energy Efficient Ethernet Will Save Power

The Commission's support of the research at the Lawrence Berkeley National Laboratory (LBNL) has been instrumental in addressing the increasing energy use from network connections and network equipment. LBNL and the University of South Florida (USF) were the first institutions to study energy use of networks in detail. Two key characteristics of Ethernet networks are that the network interfaces and network equipment have relatively constant power consumption regardless of utilization, and the majority of these connections are idle 99 percent of the time. These characteristics raised the question of whether power consumption of these devices can be varied in proportion to the actual amount of data traffic, rather than remain constant.

To address the power consumption issue, LBNL and USF worked with the Institute of Electrical and Electronic Engineers (IEEE) and other industry stakeholders to create the Energy Efficient Ethernet standard (IEEE 802.3az). The goal of this standard is to reduce power usage of network devices by 50 percent or more during low usage periods. This standard is in the final stages of development, and one product is already using the standard.

LBNL estimates that when Energy Efficient Ethernet standard is fully deployed, even with only today's count of approximately 50 million Ethernet links, savings would be about a hundred million dollars per year for California. This cost-savings does not account for additional savings from reduced data center cooling requirements or future Ethernet equipment as more audio and video devices make use of Internet connectivity. While there are costs in the standards process and in component design, any additional cost for the Energy Efficient Ethernet-capable chips will be minor in comparison to the energy savings they can produce.

This effort is part of a much broader project on Energy-Efficient Digital Networks, and there are many more avenues for using technology to leverage highly cost-effective energy savings in networks and networked devices.

Software for Selecting Energy-Saving Windows

The Commission and the U.S. Department of Energy collaborated on a first-in-the-nation project at LBNL that was completed in November 2009. The project provided utilities and building designers a way to select high-performance, energy-saving glazing and façade solutions for buildings. Highly insulating windows can provide the benefits of comfort, light, views, and ventilation without the energy losses of traditional windows.

Figure 13: Windows Test Bed



Photo Credit: Lawrence Berkeley National Laboratory

LBNL created a test bed (Figure 13) to scientifically measure performance of manufacturer-provided windows and shading devices. Before this project, utilities and designers had no accurate way to calculate the energy savings of complex commercial façade systems involving shading, glazing, and window assembly. LBNL developed a software tool called COMFEN, a commercial fenestration/façade design tool that lets designers select an appropriate energy-saving façade system. High-performance glazing and façade systems can be key components in achieving cost-effective, zero-net-energy buildings, reducing peak electricity demands, and reducing HVAC requirements. California utilities can apply the results of this research to incorporate commercial window systems into their emerging technology programs and help meet energy efficiency targets.

Control Software and Wireless Sensors for Data Centers

Completed in April 2009, this demonstration project at the California Franchise Tax Board data center used wireless sensor networks to control computer room air handlers. In addition to this technology, the project employed several best practices. Combined, these measures improved air distribution and resulted in better temperature control while achieving dramatic energy savings.

A wireless mesh-network of temperature sensors was installed in order to provide temperature feedback at the inlet to the server information technology (IT) equipment. With the mesh-network feedback provided as the input, the control software automatically determined which cooling units to operate. The software also resets the operating setpoints of the cooling units. The best practices used in this demonstration included the rearrangement of floor tiles, the installation of variable frequency drives on cooling unit fan motors, the mounting of hot-aisle containment curtains, and the filling of server rack openings, which is also known as “blanking.” The control software, the hardware, and each best practice was installed or initiated sequentially, and then evaluated using a measurement and verification procedure between each step. This sequence allowed the advantages of each approach to be quantitatively measured. Figure 14 shows a portion of the data center control system.

Figure 14: Data Center Control System



California Franchise Tax Board-Data Center Controls
Photo Credit: Lawrence Berkeley National Laboratory

The results show that the overall project reduced the baseline energy consumption of the data center by 21.3 percent, while keeping temperatures substantially within the limits recommended by ASHRAE. The entire demonstration project including the development of best practices cost \$134,057 and will save \$42,772 per year.

Commercializing Zero Energy New Solar Homes

Historically, new home developers and builders have resisted installing solar systems because of the high initial cost, aesthetics, and lack of consumer demand. Over time, the Commission and its building industry partners realized it was more cost effective to plan, design, and build energy efficiency and renewable energy features into a home before it was actually built. In 2005, the Commission launched a Zero Energy New Home (ZENH) program to help commercialize new solar homes and make building-integrated photovoltaics (BIPV) a mainstream product for California's new home construction.

SunPower Corporation of Richmond, California, was awarded a project under this program with the goal to reduce the first-cost of solar homes, homeowners' energy bill, and the summer peak electricity demand by integrating solar PV and building energy efficiency features in a cost-effective manner. SunPower explored innovative and cost-effective combinations and approaches to photovoltaic systems, energy-efficient products, home design, and strategies for the new housing construction market. It also addressed market barriers to new solar and energy-efficient homes and developed mitigation plans to overcome them. Innovative new business models and financing mechanisms were developed for all facets of commercial homebuilding design, energy analysis, and the solar installation business. Despite the poor housing market, SunPower remained committed to the objectives of the ZENH program and accomplished the following goals:

- Built four ZENH demonstration communities in California with more than 150 single- and multi-family solar homes.
- Reduced incremental first-cost of solar homes by developing innovative financing alternatives.
- Developed a new innovative business model and financing mechanism for ZENH solar homes.
- Exceeded the 2005 Title 24 requirements by 35 percent or more in ZENH building designs.
- Produced homeowner energy savings averaging 60-70 percent less than comparable non-solar housing.
- Partnered with more than two dozen national and regional homebuilders.
- Advanced energy production and usage monitoring equipment installed on all solar-equipped homes.
- Documented the merits of ZENH solar homes through customer satisfaction surveys.
- Developed new building integrated photovoltaic (BIPV) products for ZENH communities.
- Established streamlined processing standards for California's regulatory and local business practices.
- Built more than 3,000 energy-efficient solar homes in California using the results of this project. SunPower's business continues to expand across the country.

Figure 15 shows the BIPV product installed on a solar home.

Figure 15: Solar Home



SunTile, a building integrated photovoltaic product
Photo Credit: SunPower



Solar Home Built with SunTile
Photo Credit: SunPower

Both homebuilders and homebuyers have benefited from the successes of the ZENH program. California builders choosing to build solar communities realized faster sales and increased profitability. Positive homeowner experience is leading to increased referrals and improved satisfaction with their solar homes. Through surveys, focus groups, training, and other community events conducted under the project, homeowners expressed a high level of satisfaction with their ZENH solar homes.

The benefits of this program extended beyond the stated program objectives. Best-in-class packages of commercially available energy efficiency measures were developed for the ZENH demonstration homes. In addition to benefiting the most obvious market actors (builders and buyers), this program also benefited other key stakeholders in the industry, including new home sales consultants, Realtors, appraisers, lenders, permitting agencies, regulators, and other builder trade partners. The innovative business model for turnkey delivery of the solar homes developed under this project greatly removed market barriers, which helped solar installations in production communities. Additionally, SunPower received certification from the International Code Council (ICC) for its aesthetically pleasing, building-integrated SunTile solar roofing products. These products are integrated into predominant roof styles, including flat tile, asphalt shingle, and s-tile.

SunPower developed a comprehensive set of training materials and tools for builders and external marketing professionals to sell, promote, and increase the demand for ZENH homes. These materials and marketing tools were used to train solar homebuilders and sales professionals and elevate the awareness of the benefits of new solar homes. New approaches to streamlined permitting, interconnection, and incentive processing have been developed along with a concerted effort to provide enhanced customer support and warranty programs. These approaches have helped overcome many of the challenges and barriers hindering mainstream adoption of ZENH solar homes. Additionally, this project resulted in the lasting impact of helping SunPower create an entire new business unit, generating new jobs, and expanding operations throughout California and beyond.

The holistic approach of this project has fostered a deeper understanding of the challenges and risks related to commercialization of solar homes. It laid the foundation for achieving accelerated adoption and market penetration of the ZENH solar homes.

Low-Glare Light Fixture First to Earn ENERGY STAR® rating

One of the projects in the Commission's "Lighting California's Future" research program resulted in the first light fixture, or luminaire, to meet stringent ENERGY STAR®⁵ requirements for solid-state lighting luminaires. The luminaire was developed at the UC Davis California Lighting Technology Center (CLTC) in partnership with Cooper Lighting. Cooper Lighting quickly brought the product to market as the Halo LED downlight (Figure 16). The downlight's performance earned an ENERGY STAR qualification by meeting the ENERGY STAR requirements for solid-state recessed downlights.

Figure 16: Energy Star-rated Solid-State Lighting



Kitchen with Halo LED Downlights
Photo Credit: California Lighting Technology Center



Cooper Halo LED downlight
Photo Credit: California Lighting Technology Center

Using less than 15 watts, the fixture exceeds high-efficacy requirements for California's Title 24 energy code, with energy savings in exceeding 75 percent compared to a 65-watt incandescent lamp. The high efficiency of the Halo LED downlight delivers greater than 40 lumens per watt with comparable light distribution and better light output than a 65-watt BR30 lamp or 18-watt compact fluorescent fixture. The fixture provides greater than 70 percent of its initial light over 50,000 hours of use and can deliver more than 70 percent of the initial light over 20 years when used six hours per day.

Cooper Lighting first displayed the Halo LED Downlight at the prestigious Greenbuild trade show in Boston in November 2008 and the product has gone on to become one of Cooper's best selling new products in California. The rapid market acceptance of the fixture is testimony to the latent market demand for high quality, high-efficacy solid state lighting.

California utilities are promoting the Halo fixture with outreach and incentive activities to achieve their energy reduction goals. The June 2009 edition of *Buildings Magazine* highlighted the Halo fixture as a Top 100 Product, where judging criteria included aesthetics, ease of use, durability/life-cycle, efficiency or applicability, universal appeal, and sustainable/green elements. The fixture is well suited for high-ceiling applications, such as in lobbies or residential great rooms, for both new construction and retrofit projects.

⁵ ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy that helps consumers and organizations save money and protect the environment through energy-efficient products and practices.

Cool Floors, But Not Cold Feet

Peak electricity demand in California occurs during summer afternoons, so the Commission is always searching for methods for reducing electricity use at these times. Air conditioners generate one of the largest electrical loads during peak demand time.

Researchers from the UC Davis Western Cooling Efficiency Center (WCEC) found that a cooled floor slab offers an excellent alternative to air conditioning in dry climates. The temperature of the slab needs to be only slightly below normal to provide significant cooling benefits. There is no risk of workers and customers having cold feet. Water circulating through tubing in the slab can provide the small temperature drop without the need for mechanical refrigeration, thereby saving energy. The large thermal mass of the slab promotes pre-cooling during off-peak times, thereby minimizing on-peak energy use. Figure 17 shows the tubing system being installed prior to completing the concrete floor slab.

WCEC researchers worked with Walmart engineers and tubing supplier Viega to develop a tubing system that can be quickly rolled out as the floor slab is being poured. The first deployment in Las Vegas, Nevada, worked so well that Walmart decided to pilot the technology on a larger scale, including the technology in two new stores in Sacramento that opened in 2009.

Figure 17: In-Slab Cooling System



Wal-Mart High Efficiency Store with Radiant Cooling
Source: Viega Case Study, "Value Engineer Radiant Cooling"

This cooled floor design is likely to become Walmart's standard in dry climate areas throughout the United States. The in-slab tubing system eliminates three out of four rooftop air conditioners, making the initial cost lower than the baseline system, providing the same comfort with 75 percent savings in cooling energy costs.

Cleaning up Power Plants

In a February 3, 2010 memorandum, announcing the establishment of an Interagency Task Force on Carbon Capture and Storage, President Obama recognized the rapid deployment of carbon capture and storage (CCS) as a way to "help position the United States as a leader in the global clean energy race."

The Commission is leading the development of advanced electricity generation technologies in conjunction with CCS technologies through the West Coast Regional Carbon Sequestration Partnership (WESTCARB). The WESTCARB partnership comprises more than 80 organizations representing state agencies, industrial partners, academic specialists and a variety of technical consultants with critical expertise to help define the role of CCS in the future. The CCS process involves removing carbon dioxide from the atmosphere by enhancing natural processes or by capturing carbon dioxide at industrial facilities before being emitted, then storing it securely underground. Such measures will help slow the atmospheric buildup of carbon dioxide and its associated climatic effects.

The Commission is completing research in this area under U.S. DOE grants for WESTCARB. The objective of Phase I of WESTCARB was to characterize regional carbon sequestration opportunities. The objective of Phase II is to conduct pilot scale tests of promising geologic and terrestrial storage options. Currently there are two terrestrial sequestration projects underway, one in Oregon and one in California, plus two geological pilot projects under development in California and in Arizona.

Phase III of the WESTCARB program is currently in its second year of a 10-year project. The primary goal of WESTCARB Phase III is to demonstrate the feasibility, safety, and effectiveness of a large-volume of carbon dioxide injected into a deep underground geologic formation in a manner suitable for secure long-term storage. The project will provide a real-world understanding of injecting, storing, and monitoring/verification of carbon dioxide in a deep geologic formation, representative of those formations found in the western United States. Another project objective is to assess the effectiveness of the associated characterization methods, models, instruments, injection techniques, and safety assurance approaches used in the test, including innovative engineering and geologic techniques.

In 2009, with the support of the U.S. DOE, the Energy Commission and the other WESTCARB partners began an assessment of carbon dioxide separation technologies and started a process to better understand the business case for adding sulfur dioxide separation technologies to natural gas-fired powered plants. As a mechanism for achieving state energy and environmental objectives, the Commission will continue to support and conduct CCS research to demonstrate technology performance and facilitate interagency coordination to develop the technical data and analytical capabilities necessary for establishing a legal and regulatory framework for this technology in California.

Energy Innovations Small Grants Awardees Continue Their Journey

In 2009, the Energy Innovations Small Grants (EISG) program awarded slightly more than \$2.5 million in grant funding to 27 innovative electricity research projects. The projects funded by the EISG program are cutting-edge research projects that are at the “proof of concept” level and target critical energy research barriers and needs. These projects will help California achieve many of the established long term energy goals and mandates, such as 33 percent renewable energy generation by 2020, and Governor Schwarzenegger’s Executive Order S-06-06 to increase the production and use of bioenergy, including ethanol and bio-diesel fuels made from renewable resources. The EISG program examines these policies and funds projects that will help the State meet these policies.

For example, one promising renewable resource is biofuel production from algae feedstocks. The EISG program awarded Green Reactions, LLC of Carlsbad, CA a grant to fabricate and test an algae culturing and harvesting device. The device uses carbon dioxide to aid in the formation of algae and to cause bubbles that carry the algae from the bottom of the pond up to the top where it is harvested and collected. This project has the benefit of generating a renewable energy source with net zero carbon dioxide production.

Another promising renewable resource is methane found in landfills. The EISG program awarded Pacific Consolidated Industries, LLC of Riverside, California, a grant to research a gas separation process that increases the methane concentration in landfill gas to a level acceptable for an internal combustion engine or microturbine. This project has a two-fold benefit because methane is a greenhouse gas that can be used for electricity generation, which also reduces greenhouse gas emissions.

More traditional renewable energy resources, such as photovoltaics, will continue to address California energy goals. One of the barriers to widespread deployment of distributed photovoltaic resources is cost. A big part of the photovoltaic system cost is the inverter. The Commission awarded an EISG grant to Aegis Technology, Inc. of Santa Ana, California, to demonstrate the feasibility of a silicon carbide base solar inverter. Silicon carbide has the potential to operate at higher efficiencies and inverters of this type can be made smaller and

lighter than current technologies. If successful, silicon carbide inverters can be integrated into new-generation solar energy systems with overall improved system efficiency and reliability to generate more cost effective clean energy.

The EISG program has an unprecedented track record of past grant awardees continuing the technological and economical success of their projects. Over the life of the program, past awardees of the EISG program have secured approximately \$275 million in follow-up funding from various funding sources. PIER's contribution of approximately \$19 million to the EISG program has resulted in a 14 to 1 ratio of money secured by EISG alumni to initial PIER investment.

EISG alumni include successful companies such as Nanosolar, Greenvolts, Clean Energy Systems, and Appa Technologies. The following success stories began with EISG grants:

- United Innovations, Inc., was awarded the first EISG Phase II grant award to continue its promising and innovative high efficiency photovoltaic project. This certified California Small Business partnered with Raytheon and Science Foundation Arizona to produce an operating scale-version of a Photovoltaic Cavity Converter-based concentrating solar-energy system. In 2009, the Energy Commission awarded \$227,000 in subsequent funding to United Innovations, which leveraged the state funding with approximately \$900,000 from the project partners
- Brayton Energy, a California company, partnered with Southwest Solar Technologies in Arizona to break ground in 2009 for their full-scale, compressed air energy storage technology demonstration at Riverpoint Solar Research Park in Phoenix, Arizona. The project is scheduled to be completed in 2010.
- Advance Conservation Technology was assisted by EISG's technology transfer team, which negotiated a contract for an additional 181 units of its energy and water-saving Metlund® Hot Water D'MAND® System. This California company estimates an expansion to 1,800 units by the end of 2010. The total contract is valued at approximately \$350,000.
- One-Cycle Control, Inc. (OCC), was awarded the 2009 Army Achievement Award by the Department of the Army for the company's Controlled Power Electronics Controls and Conditioning technology. This technology was recognized for its innovation, relevance to the Army mission, immediate commercialization potential, and overall quality performance. OCC was recognized for its extraordinary capability to advance power electronics to an unprecedented level by demonstrating its breakthrough technology with outstanding performance.

The EISG program is another example of the Commission's dedication to promoting cutting-edge energy technologies that benefit California and the Commission's commitment to help bring these innovative technologies to the commercial market.

CHAPTER 4:

Leading California into the Clean Energy Future by Greening California's Technology Base

Commission-funded research will help lead California to a clean energy future through research investments that will help meet the state's greenhouse gas emission goals, continue improving the smart grid, achieve a higher penetration of renewable resources, move toward zero net energy smart communities and create careers in modern clean technology industries for a sustainable California economy.

The state's energy policy documents embrace these goals and make recommendations to achieve them. The Commission will implement RD&D through the PIER Program to improve energy infrastructure, efficiency, reliability, and reduced cost as called for in the *IEPR*. The Commission will continue research for "increased development of renewable electricity sources, energy efficiency and demand response ... to meet the greenhouse gas reduction goal of 1990 levels by 2020 and 80 percent below 1990 emissions levels by 2050," as described in Assembly Bill 32 and Executive Orders. The Commission will also promote RD&D to help reach the accelerated Renewable Energy Portfolio Standard of 33 percent renewable energy generation by 2020. In addition, the Commission continues to research how climate change will affect the state's energy infrastructure and its ability to serve California residents.

The Commission will continue working with California-based ARRA applicants. ARRA funding is encouraging manufacturers to market new technologies. The Commission will monitor these technologies to establish a track record of their performance and applicability to a modern California electric delivery system. This provides a great opportunity to use the knowledge gained from the various ARRA projects to identify the research gaps in fully integrating and operating all the newly installed technologies and systems.

During the last decade, the Commission normally funded R&D projects on an annual basis using funds from a single budget year. In 2009, working actively with research centers of excellence, the Commission focused funding on some centers for multiple years to ensure program and staff continuity. During 2009, the Commission experimented with larger value solicitations that have three to five times more funding available for a specific solicitation than in the past. In addition to receiving a much larger number of responses, the responses were of much higher quality and provided substantially more co-funding from participants. For the future, the PIER program is developing a longer-term view on R&D activities and is preparing a three-year budget plan to start in FY 2010-11.

Implementing a Clean Technology Multi-Year R&D Budget

A new three-year plan for R&D funding will target more resources for priority areas and is expected to attract more co-funding from project developers. This new multi-year budget will be based on the lessons learned from previous years' efforts and allocates the funding in four functional contract mechanisms that work well for R&D activities: (1) funding research centers that provide key areas of excellence needed to address the critical topics, (2) government and state institutions that have special capabilities to support California's future needs, (3) larger and interrelated competitive solicitations and (4) innovative forward thinking and high payoff research activities, such as the Energy Innovations Small Grant effort. As always, the final allocation of specific funding must be approved by the Commission before implementation.

Anticipated new and expanded research initiatives for the next three years include the following:

- Develop and demonstrate energy efficiency technologies to strive for achieving 100 percent economic energy efficiency implementation.
- Incorporate automated demand response technologies (Open Auto-DR) into California's load management strategies.
- Develop new technologies that allow higher penetration of renewable energy technologies into the electric grid.
- Develop and demonstrate zero net energy-smart communities.
- Develop low greenhouse gas-emitting alternatives to current high polluters.
- Provide new technologies and industry best practices to grow California's clean energy workforce.
- Provide national leadership in field demonstration of carbon capture and storage technologies.
- Use California's research centers of excellence as technology engines to accelerate California to a position of national leadership.
- Use the Energy Innovations Small Grant program to fund new and creative ideas from innovative small businesses, non-profits, individuals, and academic institutions.
- Create a new center to evaluate PIER research and demonstrate the benefits received by California ratepayers from PIER investments.
- Maximize California's energy-related federal stimulus funding by providing Energy Commission technical expertise and co-funding support.
- Evaluate and assess the short- and long-term environmental impacts of energy technologies on climate change.
- Research and develop technologies, tools, and methods for implementing renewable "drop-in" transportation fuels and research new value propositions to lower vehicle traction battery cost and achieve the RPS.

Repowering California for a Clean Energy Future

Commission RD&D will continue to provide new technologies, tools, standards, and protocols to help implement energy policies and meet the goals in the *IEPR*. The following information provides some insight into the specific technical areas future research funding will address.

Environmental

The Commission will focus its environmental research on climate change science, removing barriers to renewable energy and emerging technologies, maintaining or improving resource conservation, air quality, public health, water management and storage, and environmental justice. Specific research initiatives will include emerging renewable technologies, biofuel harvesting and production, carbon sequestration and other greenhouse gas reduction techniques, distributed generation strategies, water management tools, habitat conservation techniques, more efficient emission control technologies, and climate change adaptation

strategies. The Commission will assess the short- and long-term ecological impacts of various energy technologies.

The Climate Vulnerability study, scheduled to be completed at the end of 2010, will be a combination of statewide vulnerability assessments for selected sectors in California: water, coastal communities, natural ecosystems, forests, agriculture, public health, and energy. The study will consider physical and socio-economic vulnerability using models developed from previous Commission-funded research. The study will identify barriers to adaptation including regulatory, legal, cultural, financial, and other barriers to the successful implementation of adaptation measures.

Smart Grid and Storage

In 2009, the Commission selected two projects that will run through 2010. These projects will assess the scope of smart grid and storage projects funded by the U.S. DOE under the *American Recovery and Reinvestment Act of 2009* and the resulting technological gaps. These studies are crucial in developing plans for future smart grid research and maintaining interoperability among the new technologies. In addition to these studies, the Commission will conduct RD&D to increase energy efficiency, develop smart grid infrastructure, demonstrate existing and emerging storage technologies, and support the integration of renewable energy. To support the integration of renewable resources, standards must be adopted to ensure that the California Smart Grid provides an open architecture that allows access to a wide variety of technologies and the grid. The Commission will do the following:

- Work with the CPUC to develop a regulatory framework for adopting National Institute of Standards and Technology (NIST) Smart Grid interoperability and cybersecurity standards consistent with Federal Energy Regulatory Commission rulings to ensure national and international compatibility.
- Participate in the NIST Smart Grid Interoperability Panel, along with the CPUC and the California ISO, to ensure that California smart grid activities are shared nationally and that California can learn from smart grid activities in other states. In addition, the Commission will continue to coordinate with NIST on smart grid standards such as Open Automated Demand Response.
- Continue to coordinate with the CPUC, the California ISO, utilities, and stakeholders to develop smart grid plans, consistent with the requirements in Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009).
- Continue research on technologies that mitigate or resolve intermittency of renewable resources, as well as research on bidirectional power flows and power quality issues resulting from increased use of renewable resources.
- Continue research on smart grid technologies to enable load management and continue to pursue research and development that supports load management standards.

Energy storage is a key strategy for accommodating the intermittency of some renewable generation resources and can play a key role in load management. Market research is needed to create incentives to encourage the development of large energy storage projects. The Commission will continue to work with the California ISO, the CPUC, and the Federal Energy Regulatory Commission, as well as utilities and other interested parties, to determine how best to incentivize storage, including appropriate rate structures, and determine how storage can be allowed to participate across multiple electricity markets. The Commission will continue to research storage technologies to reduce cost and determine the best placement and sizing of new facilities to maximize electric system value.

Central Power Plant Generation

The Commission will continue to research ways to achieve a 33 percent renewable electricity goal. In pursuit of this goal, the Commission will work with other agencies such as the CPUC, the Renewable Energy Transmission Initiative, the Desert Renewable Energy Conservation Plan, the California ISO, the federal Bureau of Land Management, and the California Department of Fish and Game to accelerate deployment of new central station renewable generation and supporting transmission facilities while preserving California's environment.

Distributed Generation

The Commission will perform additional research and development to reduce costs for biomass conversion, biopower technologies, and environmental controls for distributed generation (DG) to meet the Governor's target of 20 percent of the state's renewable energy goals from biomass resources (Executive Order S-06-06). The Commission will facilitate and coordinate projects with other state and local agencies to address barriers to the expansion of biopower.

The Commission will develop tools to forecast operational performance of solar energy DG facilities including solar thermal electric systems, and rooftop, community-scale, and utility-scale photovoltaic systems. These tools will also examine how power plant-based storage can limit the impact of errors in forecasting wind and solar energy production.

The Commission will also coordinate ongoing research with the Air Resources Board on DG using combined heat and power (CHP) systems to meet the state goals for emission reductions from this technology. Research will include benefit/cost analyses to reduce barriers to the development of CHP facilities. The Commission will continue research to lower costs, increase reliability, lower emissions, and strive to inform policy so that CHP is widely viewed and adopted as an energy efficiency measure.

The Commission frequently solicits input and feedback from the public on future RD&D needs for California. In 2009, the Commission developed a roadmap to meet the RD&D needs for distributed generation. Representatives from manufacturers, electric and gas utilities, energy service providers, universities, national laboratories, public agencies, technology users, and other advanced generation interest groups, such as the Electric Power Research Institute and the Gas Technology Institute contributed. This roadmap identifies and prioritizes various initiatives for RD&D that provide cost effective and sustainable DG options. Research is needed to integrate packaged CHP and combined cooling, heating, and power (CCHP) systems into the smart grid. The roadmap also includes an implementation plan to research advanced generation technologies to achieve California energy policy goals such as the Renewable Energy Portfolio Standard and greenhouse gas emission reductions.

Transmission and Distribution for Renewables

The Commission will continue to research ways to support a 33 percent renewable electricity goal. In pursuit of this goal, the Commission will work with other agencies, such as the California Public Utilities Commission, the California ISO, the federal Bureau of Land Management, and the California Department of Fish and Game, to accelerate permitting of new transmission facilities. The Commission will continue to coordinate with working groups, such as the Renewable Energy Transmission Initiative and the Desert Renewable Energy Conservation Plan, to identify research to achieve clean energy development while protecting the environment. The Commission will also continue to research solutions to operational issues posed by renewable generation integration.

Further, the Commission will continue working with the California utilities, California ISO, the DOE, BPA, the Western Electricity Coordinating Council (WECC), and other regional

organizations to address the transmission and distribution issues in achieving better renewable generation integration.

Transportation Sector

PIER Transportation will conduct research in three focus areas stated below to help meet the goals of the State Alternative Fuels Plan and the vehicle-use reduction goals stipulated in SB 375 (Steinberg, Chapter 728, Statutes of 2007).

Vehicle Technologies

The Vehicle Technologies focus area identifies opportunities to enable alternative-fueled vehicles by promoting improved fuel efficiency and energy savings through innovations in vehicle components, systems, and platforms. Additionally, research in this area must reduce vehicle tons of carbon dioxide per mile beyond proposed standards. Vehicle Technologies research areas include:

- Continued development of plug-in hybrid electric vehicle (PHEV) technology through the PHEV Research Center at UC Davis.
- Development of advanced medium- and heavy-duty vehicle efficiency technologies.
- Development of advanced, medium- and heavy-duty natural gas engine technologies.
- Development of on-board natural gas storage technologies.

Alternative Fuels

The Alternative fuels research area seeks to reduce consumption of petroleum-based fuels in transportation through advancement of a variety of renewable and non-renewable alternative fuels and production opportunities. This research area also includes low-carbon fuels and beneficial in-state resource development. Alternative fuels research areas include:

- Development of interchangeable renewable fuels.
- Enhancement of alternative fuels' compatibility with existing infrastructure.
- Inclusion of renewable aviation fuels research efforts in a comprehensive RD&D technology portfolio.
- Life-cycle analyses for carbon and sustainability determinations.

Transportation Systems

The Transportation Systems focus area will conduct research to identify and quantify complex interrelationships that characterize our modern transportation systems. Examples of these interrelationships include those among our built environment, roads, and fueling. Others include infrastructure and goods movement. Transportation systems research provides tools, methods, and information needed to avoid shifting transportation energy problems from one sector to another, thereby defining pathways to permanent and verifiable carbon reductions within these systems. Transportation systems research areas include:

- Development of a systems approach to quantify linkages between transportation energy consumption, land-use patterns, and socio-economic and institutional factors.
- Development of tools to better integrate transportation energy considerations into regional and local planning.
- Implementation of electric fuel in coordination with the emerging smart grid.

Energy End Use

The Commission will research effective building and appliance technologies that put California on the path to zero net energy residential buildings by 2020 and zero net energy commercial buildings by 2030.

The Commission will research new and emerging energy efficiency technologies suitable for retrofitting existing buildings as well as energy efficiency techniques for building maintenance and commissioning to optimize all cost-effective energy efficiency measures. The Commission will also conduct research to determine optimal levels of energy efficiency needed before installing on-site renewable energy resources and incorporating efficiency measures into building codes. Future research also involves examining the relationship of resource life cycle and the built environment, the relationship of human behavior and its effect on energy savings, and understanding and overcoming barriers to energy efficiency deployment in residential and commercial buildings not owned by tenants.

Upcoming research projects include a demonstration of a Concentrating Solar Power – Dish/Engine (CSP-D/E) (Figure 18) technology on a 1 MW scale at a wastewater treatment plant specifically to offset the plant's electrical usage and costs during peak demand periods. The proposed solar array would occupy approximately five acres of land and consist of 330 individual CSP dish units, each 15 feet in diameter. Wastewater treatment plants represent a municipal sector that often have available land, minimal surrounding development, and use an appreciable amount of power in every community in California. This technology is estimated to reduce energy demand from wastewater facilities by 20 to 35 percent. Figure 1 shows a CSP-D/E system installed in Spain.

Figure 18: Solar System (ISS) Dish Collector/Engine System



Concentrated Solar Power-Dish/Engine units in Spain
Photo Credit: Infinia Corporation 2010

Carbon Capture and Storage

Due to the current high costs of implementing CCS with conventional power generating systems, advanced electricity generation must be developed that will minimize the costs to ratepayers in a carbon-constrained environment. The WESTCARB team will continue to demonstrate small-scale carbon dioxide injections in both Arizona and California. The result of this research will provide valuable information to help the state and the nation determine the value of CCS in future state greenhouse gas reductions policies and plans. The results from all three phases of the 10-year project will make a vital contribution to the scientific, technical, and

institutional knowledge necessary to establish frameworks for the development of commercial carbon sequestration projects in California. The research will also inform policy-makers and stakeholders in the development of public policy instruments addressing carbon dioxide emission reductions. In 2010, the Commission will initiate research to determine the cost effectiveness of adding CCS to existing natural gas power plants.

Energy Innovations Small Grants Program

In 2010, the EISG program expects to release multiple solicitations: four solicitations for electricity, two for natural gas, and two for transportation. These numbers are subject to change based on the quality and quantity of proposals received for each solicitation. Proposal concepts for the transportation solicitations include research addressing vehicle efficiency improvements, batteries, electric vehicles, and sustainable communities modeling, and the solicitations will likely result in the Commission funding dozens of projects.

Future Research Centers

Agricultural and Food Processing

The Commission plans to establish an agricultural and food processing research center at a California State University (CSU) or UC campus. The center will serve as a forum for public and industry outreach and as an information clearinghouse for cutting-edge technology research. Industry partners will initiate projects addressing energy and water efficiency technologies and will interface with the future clean workforce. The research center will connect government, industrial, and academic entities.

Appliance and Electronics Technology

The Commission plans to establish a research center in Southern California that will focus on consumer electronics and appliances, which consume an increasing share of electric energy in houses and offices. Normally, electronics manufacturers focus more on speed and performance rather than energy efficiency. This center will partner with manufacturers to develop technologies that optimize both performance and efficiency.

Clean Workforce Development

Even though building energy management system faults can waste huge amounts of energy, these faults are difficult to detect and diagnose by untrained building operators and technicians. The Commission will partner with California community colleges, LBNL, and outside software developers to establish a clean workforce center to train building operators and technicians in the operation of complex building energy management systems.

APPENDIX A

2009 INDIVIDUAL PROJECTS

This appendix contains a summary of the project work performed during the calendar year of 2009. The table includes the SB 1250 goals, agreement number, company name, project title, project amount, and start date. PIER research projects initiated in 2009 totaled \$97.5 million. The difference can be attributed to projects from 2008 that were not signed until 2009.

The summary table below shows the total project funding and number of projects in 2009 for each SB 1250 goal.

Summary of Calendar Year 2009 Projects by SB 1250 Policy Goals		
SB 1250 Policy Goal	Total Project Funding	Number of Projects
Advanced Electricity Generation	\$3,747,356	12
Climate/ Environmental	\$17,118,772	49
Energy Efficiency and Demand Response	\$33,796,866	56
Renewables	\$22,931,008	58
Transmission and Distribution	\$7,296,144	9
Transportation	\$12,564,822	19
Grand Total	\$97,454,968	203

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Advanced Electricity Generation	500-98-014	Pennsylvania State University	High G-Load Combustor for Microturbines	\$95,000	2/1/2009
Advanced Electricity Generation	500-98-014	UC Riverside	Metallic Nanotubes as Low-Cost and Durable Fuel Cell Catalysts	\$95,000	4/30/2009
Advanced Electricity Generation	500-98-014	Nanotron	Nanowire thermoelectrics for industrial waste heat recovery	\$95,000	10/15/2009
Advanced Electricity Generation	500-98-014	University of California, Irvine	Transient operation and control of fuel cell temperature variations	\$50,000	10/15/2009
Advanced Electricity Generation	500-98-014	Materials and Systems Research, Inc.	Development of a Petcoke-fueled SOFC Power Generator for on-site Application	\$94,931	11/10/2009
Advanced Electricity Generation	500-98-014	University of California, San Diego	Direct Solid Oxide Fuel Cells	\$95,000	11/10/2009
Advanced Electricity Generation	PIR-08-022	Tecogen, Inc.	New Engine Technology for California's Combined Heat and Power Market	\$999,824	7/27/2009
Advanced Electricity Generation	PIR-08-023	Sturman Industries	Improving Efficiency of Spark Ignited, Stoichiometrically-operated Natural Gas Engines	\$997,696	6/30/2009
Advanced Electricity Generation	NCI-06-027-P-R	Navigant Consulting, Inc.	PIER Advanced Generation Program Roadmap	\$189,907	4/13/2009
Advanced Electricity Generation	PIR-07-006	ICF International	Dehumidification/Heating Combined Heat and Power System	\$460,062	2/18/2009
Advanced Electricity Generation	ICF-06-032-P-R	ICF Resources, LLC	Combined Heat and Power Technical and Market Assessment	\$174,935	2/23/2009
Advanced Electricity	500-09-005	Lawrence Livermore National	AB 1925 Report for 2010	\$400,000	11/16/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Generation		Laboratory			
Climate/ Environmental	500-08-034	UC Irvine	Gaseous Fuel Interchangeability Criteria Development	\$1,132,714	5/28/2009
Climate/ Environmental	500-08-059R	Lawrence Berkeley National Laboratory	Cool Communities	\$785,000	6/30/2009
Climate/ Environmental	BOA-99-223-P	UC Berkeley	Center for Resource Efficient Communities (CREC)	\$450,000	6/19/2009
Climate/ Environmental	PIR-08-029	University of California, Davis, Wildlife, Fish & Conservation Biology Department	Research on Hydropower Effects on a Fish Species of Special Concern	\$ 441,797	6/30/2009
Climate/ Environmental	500-98-014	Georgia Institute of Technology	A New Approach to Carbon Dioxide Capture	\$88,972	2/1/2009
Climate/ Environmental	BOA-99-217-P	The Regents of the University of California, Office of the President - CIEE	Funding for UC Energy Institute to operate the Center for the Study of Energy Markets	\$228,862	3/1/2009
Climate/ Environmental	500-98-014	The Regents of the University of California, San Diego	Nitric oxide reduction using oxy-combustion in stationary power engines	\$95,000	10/15/2009
Climate/ Environmental	500-08-005	UC Davis	Modeling Integrated Adaptation to Climate Change for Californias Water Supply and Hydropower Systems	\$300,000	8/24/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals

SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Climate/ Environmental	500-08-007	Altostratus, Inc.	MultiEpisodic and Seasonal Impacts of and Emissions Credits from Heat Island Mitigation Strategies	\$200,000	4/16/2009
Climate/ Environmental	500-08-013	Pacific Northwest National Laboratory	Integrated Climate Technology Analysis for California	\$228,337	5/28/2009
Climate/ Environmental	500-08-020	UC Santa Barbara	Advanced modeling of the biological effects of climate change in California	\$300,000	2/2/2009
Climate/ Environmental	500-08-031	UC Berkeley	Research on Hydropower Effects on an Amphibian Species of Special Concern II	\$299,992	4/13/2009
Climate/ Environmental	500-08-045	California Council on Science and Technology	California's Energy Future: Assessing our Technical Capacity to meet 2050 Climate and Energy Goals	\$50,000	5/28/2009
Climate/ Environmental	500-08-046	Scripps Institution of Oceanography - UC San Diego	Joint Cloud Condensation Nuclei - Micro-channel Capillary Electrophoresis device for measuring droplet chemistry of cloud active aerosols: Phase I	\$199,077	6/30/2009
Climate/ Environmental	500-08-055	UC Riverside	Improving Understanding of Regional and Near-source Air Quality Impacts of Distributed Generation Sources	\$650,000	6/30/2009
Climate/ Environmental	500-09-007	CSU Fullerton Auxiliary Services Corporation	Estimation of Methane Emissions from the California Natural Gas System	\$600,000	8/31/2009
Climate/ Environmental	500-09-009	UC Davis	Adaptation Strategies for Agricultural Sustainability in Yolo County, California	\$290,000	12/1/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Climate/ Environmental	500-09-012	US Geological Survey	Carbon sequestration and GHG emissions in intentionally flooded corn fields in the Delta	\$449,145	12/14/2009
Climate/ Environmental	BOA-99-216-P	Scripps Institution of Oceanography - UC San Diego	CEC-NOAA Study: Winter 2009	\$140,000	2/18/2009
Climate/ Environmental	BOA-99-221-P-R	Lawrence Berkeley National Laboratory	Climate Change and California's Energy Infrastructure: Phase I	\$400,000	5/8/2009
Climate/ Environmental	BOA-99-226-P	UC Davis Center for Watershed Sciences	Foothill Yellow-legged Frog (<i>Rana boylei</i>) Tadpole Lateral Movement Study	\$18,000	6/12/2009
Climate/ Environmental	BOA-99-227-P	The Regents of the University of California, Office of the President - CIEE	Climate Change and Energy: IEPR Discussion Papers	\$16,800	6/12/2009
Climate/ Environmental	BOA-99-228-P	The Regents of the University of California, Davis	Determining and Valuing the Effects of Temperature and Heat Waves on Mortality and Morbidity in California	\$224,161	7/9/2009
Climate/ Environmental	BOA-99-230-P	Lawrence Berkeley National Laboratory	California GHG Targets and CHP Incentives	\$50,000	8/12/2009
Climate/ Environmental	BOA-99-236-R	The Regents of the University of California, Office of the President - CIEE	Quantification of Black Carbon Emissions from Cookstoves	\$99,999	8/27/2009
Climate/ Environmental	BOA-99-240-P-R	The Regents of the University of California, San Diego	Deployment of Ground-based Aerosol Time of Flight Mass Spectrometer	\$416,000	9/21/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Climate/ Environmental	MRA-02-080	UC Berkeley	Grinnell Resurvey Project	\$124,747	2/2/2009
Climate/ Environmental	PIR-08-001	UC Berkeley	Assessing Long-term Dynamics of Bird Distributions in Relation to Climate Change: From Grinnell to Present	\$199,999	2/2/2009
Climate/ Environmental	PIR-08-002	Rand Corporation	Developing Flexible and Robust Water Management Climate Change Adaptation Strategies in the Sierra Nevada	\$199,491	3/11/2009
Climate/ Environmental	PIR-08-003	UC Santa Cruz	Informing Climate Change Models with Stand Level Ecological Data: Valley Oak Woodlands in California	\$68,725	2/16/2009
Climate/ Environmental	PIR-08-004	UC Davis	N2O Emissions from the Application of Fertilizers in Agricultural Soils	\$499,960	6/30/2009
Climate/ Environmental	PIR-08-005	UC Irvine	Reductions in urban outdoor water use as an adaptation to rising temperatures and declining water supplies in Southern California	\$199,737	6/30/2009
Climate/ Environmental	PIR-08-006	UC Davis	Systematic Terrestrial Vegetation Data Development for Climate Change Studies	\$199,997	1/5/2009
Climate/ Environmental	PIR-08-007	UC Davis	Reducing Greenhouse Gas Emissions Through Local Government Action: Case Studies of Five California Cities	\$262,323	6/30/2009
Climate/ Environmental	PIR-08-009	Lawrence Berkeley National Laboratory	California's Carbon Challenge: An Integrated Modeling Framework to Reduce GHG Emissions in California by 2050	\$400,000	9/15/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Climate/ Environmental	PIR-08-030	Altostratus, Inc.	Ranking and Prioritizing the Deployment of Community-Scale Energy Technologies Based on Their Indirect Effects in California Climate Zones	\$120,492	6/30/2009
Climate/ Environmental	UC MR-061	Center for Aquatic Biology and Aquaculture - UC Davis	Evaluating and Predicting Habitat Suitability for California Salmon: Improving Models through a Holistic Perspective	\$123,029	3/1/2009
Climate/ Environmental	UC MR-061	Center for Aquatic Biology and Aquaculture - UC Davis	Improving Environmental Flow Methodologies used in California FERC Relicensing	\$166,655	3/1/2009
Climate/ Environmental	UC MR-061	Center for Aquatic Biology and Aquaculture - UC Davis	21st Century Instream Flow Assessment Framework for Mountain Streams	\$158,738	3/1/2009
Climate/ Environmental	UC MR-061	Center for Aquatic Biology and Aquaculture - UC Davis	Integrating Bioenergetics, Spatial Scales and Population Dynamics for Environmental Flow Assessments	\$138,400	8/31/2009
Climate/ Environmental	500-08-006	The Regents of the University of California, Office of the President - CIEE	Funding for UC Energy Institute to operate the Center for the Study of Energy Markets	\$2,394,375	5/29/2009
Climate/ Environmental	500-08-036	CTG Energetics, Inc.	Energy and Greenhouse Gas Assessment Protocols for Built Environments	\$684,667	6/30/2009
Climate/ Environmental	500-08-019	Lawrence Berkeley National Laboratory	Atmospheric Measurements and Modeling for Verification of AB-32 Mandated GHG Emissions Reductions	\$505,000	4/13/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Climate/ Environmental	500-08-030	Facet Decision Systems, Inc	Environmental Siting Model and Renewable Scenario Support	\$510,100	4/13/2009
Climate/ Environmental	500-08-033	Hydrologic Research Center (HRC)	INFORM II	\$1,000,000	4/27/2009
Climate/ Environmental	500-08-021	California Department of Conservation	West Coast Regional Carbon Sequestration -- Phase II Geological Characterization	\$274,067	4/9/2009
Climate/ Environmental	500-08-057	United States Carbon Sequestration Council	West Coast Regional Carbon Sequestration Partnership - Phase II, Membership in United States Carbon Sequestration Council	\$35,000	6/15/2009
Climate/ Environmental	PIR-08-008	Winrock International	Deforestation in California: A poorly understood GHG emission source and emission reduction opportunity	\$299,424	2/2/2009
Climate/ Environmental	PIR-08-010	Desert Research Institute	Investigation of Methods of Potential Value to Monitor Groundwater Recharge in the Mountains of California	\$399,990	3/21/2009
Energy Efficiency and Demand Response	500-08-029	UC Los Angeles	Getting to 2020	\$708,245	4/30/2009
Energy Efficiency and Demand Response	500-08-042	Western Cooling Efficiency Center - UC Davis	Western Cooling Efficiency Center Research	\$2,100,000	6/22/2009
Energy Efficiency and Demand Response	500-08-050	Sensus MI	Enterprise Plug n Play Diagnostics and Optimization for Smart Buildings	\$1,262,252	6/30/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Energy Efficiency and Demand Response	500-08-053	UC Davis	Realizing Energy Efficient Lighting in California	\$3,200,000	6/30/2009
Energy Efficiency and Demand Response	500-08-061	Lawrence Berkeley National Laboratory	Residential Energy Savings from Air-tightness and Ventilation Excellence	\$1,688,155	6/30/2009
Energy Efficiency and Demand Response	500-09-003	Lawrence Berkeley National Laboratory	Action-oriented Benchmarking - EnergyIQ Tool Enhancements and Service Extension Upgrades	\$636,000	9/1/2009
Energy Efficiency and Demand Response	PIR-08-011	Becker Engineering Company	Green Guide for Sustainable Energy Efficient Refrigerated Warehouses	\$106,750	6/15/2009
Energy Efficiency and Demand Response	PIR-08-013	Lawrence Berkeley National Laboratory	Lighting Control User Interface Standards	\$168,000	6/15/2009
Energy Efficiency and Demand Response	PIR-08-015	Lighting Research Center - Rensselaer Polytechnic Institute	A Platform for Innovation in Solid-State Lighting	\$294,942	6/15/2009
Energy Efficiency and Demand Response	PIR-08-020	BETA Lighting	Networked LED Streetlights with Intelligent Controls	\$300,000	6/15/2009
Energy Efficiency and Demand Response	PIR-08-021	ConSol	Strategies to Eliminate Peak Air Conditioning Loads	\$292,173	7/15/2009
Energy Efficiency and Demand Response	500-08-051	Gas Technology Institute	Advanced Radiant HVAC Systems for California Homes	\$1,989,598	6/30/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Energy Efficiency and Demand Response	PIR-08-014	Lawrence Berkeley National Laboratory	Energy Implications of In-Line Filtration in California Residences	\$172,000	7/29/2009
Energy Efficiency and Demand Response	500-08-060	Gas Technology Institute	Residential Water Heating Program	\$1,984,761	6/30/2009
Energy Efficiency and Demand Response	500-98-014	Miami University - Ohio	Novel Heat Exchanger Fin Surface Design for Improved Condensate Management	\$77,993	2/1/2009
Energy Efficiency and Demand Response	500-98-014	Exergy Controls, LLC	Demand Response Load Shedding System for Lighting	\$94,895	2/1/2009
Energy Efficiency and Demand Response	500-98-014	Energy Concepts Company	Charge Air Chiller	\$95,000	2/1/2009
Energy Efficiency and Demand Response	500-98-014	Proctor Engineering Group	Proportional Time Delay for Air Conditioner Latent Capacity Recovery	\$91,470	4/30/2009
Energy Efficiency and Demand Response	500-98-014	University of Alaska, Fairbanks	Optimized SHEV Control Strategies for Reduced Fuel Consumption and Emissions	\$95,000	4/30/2009
Energy Efficiency and Demand Response	500-98-014	UC San Diego	Novel energy saving light bulb	\$94,909	10/15/2009
Energy Efficiency and Demand Response	500-98-014	ThermAvant Technologies, LLC	Heat-Activated cooler with two-stage, multi-fluid ejector and novel mixing chamber	\$95,000	10/15/2009
Energy Efficiency and Demand Response	500-01-043	The Regents of the University of California, Office of the President -	Development of Self-Correcting Building HVAC Controls (PNNL)	\$125,000	9/1/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
		CIEE			
Energy Efficiency and Demand Response	500-01-043	The Regents of the University of California, Office of the President - CIEE	An Integrated and Cognitive Home Energy Management System for Demand Response (SDSU)	\$249,909	9/1/2009
Energy Efficiency and Demand Response	500-98-014	Applied Lighting Solutions	High Efficiency LED Luminaires using Low Cost Compact Cooling Technology	\$95,000	11/10/2009
Energy Efficiency and Demand Response	KEMA-06-021-P-R	KEMA, Inc.	Assessment of Advanced Storage Impact on Demand Side Services	\$98,900	2/23/2009
Energy Efficiency and Demand Response	KEMA-06-025-P-R	KEMA, Inc.	Customer-Side Energy Storage for Demand Response & Reliability.	\$26,441	8/26/2009
Energy Efficiency and Demand Response	BOA-99-205-P	Lawrence Berkeley National Laboratory	Research Opportunities in Emerging and Under-Utilized Energy-Efficient Industrial Technologies	\$84,000	1/1/2009
Energy Efficiency and Demand Response	MRA-02-081	Lawrence Berkeley National Laboratory	IAW Storage Viability and Optimization Site	\$180,000	2/18/2009
Energy Efficiency and Demand Response	MRA-02-082	UC Irvine	Energy Reduction in Membrane Filtration Processes through Optimization of Nanosuspended Particles Removal	\$124,985	10/1/2009
Energy Efficiency and Demand Response	NCI-06-032-P-R	Navigant Consulting, Inc.	Identify RD&D Targets for PIER Industrial, Agricultural and Water Energy Efficiency Program	\$99,986	6/15/2009
Energy Efficiency and	500-08-024	Portland State University	Advanced Residential Energy and Behavior	\$1,213,787	7/24/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Demand Response			Analysis Project		
Energy Efficiency and Demand Response	500-08-049	New Buildings Institute, Inc.	Evidence-Based Design & Operations: Improving the Real World Performance of High-Performance Buildings	\$1,971,152	6/30/2009
Energy Efficiency and Demand Response	BOA-99-229-P	Lawrence Berkeley National Laboratory	ASHRAE 62.1 study in retail buildings	\$275,000	7/9/2009
Energy Efficiency and Demand Response	BOA-99-232-R	Lawrence Berkeley National Laboratory	Energy Efficiency Research for California Hospitals	\$350,000	9/1/2009
Energy Efficiency and Demand Response	BOA-99-224-P	Western Cooling Efficiency Center - UC Davis	WCEC Retrofit Strategies for Retail Buildings	\$175,000	5/11/2009
Energy Efficiency and Demand Response	PIR-08-017	Purdue University Herrick Lab	Optimizing Refrigerant Distribution in Evaporators	\$249,729	6/15/2009
Energy Efficiency and Demand Response	PIR-08-016	Benningfield Group	Demonstration of Field Effectiveness of Classroom Single Zone VAV Units	\$178,370	7/15/2009
Energy Efficiency and Demand Response	500-08-023	Gas Technology Institute	Energy and Water Recovery with Transport Membrane Condenser	\$479,650	5/28/2009
Energy Efficiency and Demand Response	500-08-026	Southern California Gas Company	Energy Efficiency Calculator Tools	\$200,000	5/28/2009
Energy Efficiency and Demand Response	500-08-037	Gas Technology Institute	Waste Heat Recovery from Corrosive Industrial Exhaust Gases	\$490,000	5/28/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Energy Efficiency and Demand Response	500-09-002	Lawrence Berkeley National Laboratory	Data Center Energy Efficiency and Demonstration Projects	\$865,000	8/13/2009
Energy Efficiency and Demand Response	500-08-035	L Monte Information Services	Building Energy Standards Modeler Demonstration Program	\$1,826,761	5/25/2009
Energy Efficiency and Demand Response	500-08-039	California Commissioning Collaborative	Building Commissioning: Strategies and Technologies for Energy Efficiency	\$1,796,630	5/25/2009
Energy Efficiency and Demand Response	500-08-040	Rensselaer Polytechnic Institute	Lighting Research Center Partnership	\$60,000	5/25/2009
Energy Efficiency and Demand Response	500-08-044	Center for the Built Environment - UC Berkeley	Advanced Building Systems Technology Development	\$2,100,000	6/30/2009
Energy Efficiency and Demand Response	500-08-052	Lawrence Berkeley National Laboratory	Development of Diagnostic and Measurement and Verification Tools for Commercial Buildings	\$1,959,879	6/30/2009
Energy Efficiency and Demand Response	BOA-99-210-P	Center for the Built Environment - UC Berkeley	Advanced Integrated Systems Development	\$200,000	2/2/2009
Energy Efficiency and Demand Response	BOA-99-225-P	Center for the Built Environment - UC Berkeley	Integrated Systems Tools Development and Performance Testing	\$280,000	7/9/2009
Energy Efficiency and Demand Response	BOA-99-239-R	Lawrence Berkeley National Laboratory	Development of LearnHVAC Teaching Tool	\$350,000	5/11/2009
Energy Efficiency and Demand Response	500-09-010	Lawrence Berkeley National Laboratory	Development of a Design GUI for EnergyPlus	\$900,000	11/9/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Energy Efficiency and Demand Response	500-98-014	Auburn University	Reducing Natural Gas Consumption by Modifying Containers of Water Heaters	\$95,000	2/1/2009
Energy Efficiency and Demand Response	500-08-028	State Water Project Contractors Authority	Analysis and Optimization of Water and Energy Balances for Storage and Conveyance Systems	\$400,000	4/7/2009
Energy Efficiency and Demand Response	NCI-06-026-P-R	Navigant Consulting, Inc.	Analysis and Implications of Existing Home Energy Efficiency Goals in the California Energy Efficiency Strategic Plan	\$149,757	3/16/2009
Energy Efficiency and Demand Response	PIR-08-018	Bevilacqua-Knight, Inc.	Technology and Strategies for AB32 Compliance in the Existing Homes Sector	\$199,972	6/15/2009
Energy Efficiency and Demand Response	PIR-08-019	Bruce Wilcox	Energy Efficiency Characteristics of New California Homes	\$296,501	7/15/2009
Energy Efficiency and Demand Response	SAIC-06-043-P-R	Bruce Wilcox	Research to Support Improvements in Residential Compliance Tools	\$103,314	1/5/2009
Renewables	PIR-08-025	Kenneth Shawn Smallwood	Comparing Utilization Data for Siting New Wind Power Generation	\$181,800	6/30/2009
Renewables	PIR-08-012	Harpiris Energy	Harpiris Solar Storage Tank	\$284,500	6/15/2009
Renewables	500-98-014	University of Arkansas Division of Agricultural-Cooperative Extension Services	Production of Syngas from Dairy Manure to Replace Natural Gas	\$95,000	2/1/2009
Renewables	500-98-014	Energetics, Inc	Algae Biomass Gasification	\$94,500	2/1/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Renewables	500-98-014	UC Davis	Tandem Organic Solar Cell Using CNT and Mixed Quantum Dots	\$81,463	2/1/2009
Renewables	500-98-014	BioEnergy Solutions, LLC	Low-Cost Hydrogen Sulfide Reduction in Biogas Energy Systems	\$93,896	2/1/2009
Renewables	500-98-014	UC Davis	Feasibility Study of a Novel Biochemical Route for Ethanol Production	\$95,000	4/30/2009
Renewables	500-98-014	Rutgers University	Flexible Zinc and Copper Based Solar Cells	\$95,000	4/30/2009
Renewables	500-98-014	The Regents of the University of California, San Diego	Micro-Optic Slab Concentrators for Low-Cost Solar Panels	\$95,000	4/30/2009
Renewables	500-98-014	University of Florida	Biomimetic Antireflection Coatings for Highly Efficient Solar Cells	\$95,000	4/30/2009
Renewables	500-98-014	The Regents of the University of California, San Diego	Semiconductor Quantum Dot Based Heterostructures for High-Efficiency Photovoltaics	\$95,000	4/30/2009
Renewables	500-98-014	UC Santa Cruz	Fully printed all inorganic nanoparticle-based solar cells	\$95,000	11/10/2009
Renewables	500-98-014	Aegis Technology Inc.	High-efficiency, Compact Silicon-Carbide-based Solar Inverter	\$95,000	11/10/2009
Renewables	500-98-014	Broome & Associates	Verification Test Undershot Impulse-Jet Hydro-Turbine at Turlock Irrigation Districts Drop-MD6	\$95,000	11/10/2009
Renewables	500-98-014	Mark Convery	Closed-loop Tracking for Solar Thermal Heliostats	\$89,000	11/10/2009
Renewables	500-98-014	Iowa State University, Dept of Mechanical Engineering	Development of High-Efficiency and Cost-effective Micro Wind Turbines	\$94,868	11/10/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Renewables	500-98-014	Green Reactions LLC	Osprey: Ultra efficient mass microalgae culturing and harvesting device	\$95,000	11/10/2009
Renewables	500-98-014	Missouri Science & Technology	Module-level Power Converters for Parallel-Connected Photovoltaic Arrays	\$94,998	11/10/2009
Renewables	500-98-014	Torrey Hills Technologies, LLC	Low Cost Dye Sensitized Solar Cells	\$95,000	11/10/2009
Renewables	500-98-014	Iowa State University	Innovative biogas hydrogen sulfide removal technology	\$95,000	10/15/2009
Renewables	500-98-014	The Regents of the University of California, Davis	Improving high-solids biomass conversion efficiency using spray-dried enzymes	\$93,019	10/15/2009
Renewables	500-98-014	University of California, San Diego	Developing ultrahigh-efficiency thermal-to-electric energy conversion technique	\$95,000	10/15/2009
Renewables	500-98-014	Pacific Consolidated Industries, LLC	Renewable energy through purification of low-BTU landfill gas	\$95,000	10/15/2009
Renewables	500-09-011	United Innovations, Inc.	Production of an Operating Photovoltaic Sub-Module for Integration into a High-Efficiency Power Conversion Unit	\$226,961	11/23/2009
Renewables	KEMA-06-024-P-S	KEMA, Inc.	Facilitation of the Results Gained from the Research Evaluation of Wind Generation, Storage Impact, and Demand Response on the CA Grid	\$53,237	5/26/2009
Renewables	500-98-014	Sunprint Inc.	Printing Low Cost Solar Cell with Ultrasonic Ejection	\$93,350	10/15/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Renewables	BOA-99-243-S	The Regents of the University of California, Office of the President - CIEE	Statistician for Avian Research Project Review	\$40,857	12/9/2009
Renewables	BOA-99-247-R	The Regents of the University of California, Office of the President - CIEE	Environmental Impacts of Using Forest Biomass for Energy Production	\$99,409	12/18/2009
Renewables	PIR-08-024	US Forest Service Pacific Southwest Research Station	Improving the Accuracy and Cost-effectiveness of Pre-Construction and Operations Monitoring Efforts for Bats and Birds at Wind Energy Facilities in California	\$550,948	7/15/2009
Renewables	PIR-08-027	H.T. Harvey and Associates	Radar, Acoustic and Observational Study to Assess Bat and Bird Movements and Mortality Relative to Old and New Wind Tower Structures	\$732,411	6/30/2009
Renewables	PIR-08-028	California Wind Energy Association (CALWEA)	Improving Methods to Assess and Mitigate Impacts of Wind Energy Development on Birds and Bats in California: Synthesizing and Analyzing a Database to Empirically Evaluate Key Issues, and Validating Fatality Estimation Methods	\$442,078	7/29/2009
Renewables	SAIC-06-041-P-S	Susan Sanders Biological Consulting	RFP Solicitation and Proposal Review Support for PIER Research on Bird and Bat Collisions with Wind Turbines in California	\$8,326	1/5/2009
Renewables	SAIC-06-042-P-R	Susan Sanders Biological	Bird and Bat Collisions with Wind Turbines	\$4,646	1/5/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
		Consulting	Bibliography		
Renewables	500-07-038	WaterReuse Foundation	Assess Water Use Requirements and Establish Water Quality Criteria for the Application of Water Reuse Energy, Power, and Biofuels Production (WRF-08-12 / TT-06-15)	\$149,871	9/1/2009
Renewables	500-07-038	WaterReuse Foundation	Implications of Future Water Supply Sources on Energy Demands (WRF-08-16 / TT-06-09)	\$100,000	8/1/2009
Renewables	500-08-008	Southern California Edison	Self-Audit Of Wastewater Treatment Processes To Achieve Energy Optimization, Phase 1	\$300,000	5/18/2009
Renewables	500-08-009	Sacramento Municipal Utility District	SMUD Micro-Grid Demonstration	\$1,586,290	5/28/2009
Renewables	PIR-08-043	The Regents of the University of California, San Diego	Enabling Renewable Energy, Energy Storage, Demand Response and Energy Efficiency with a Community Based Master Controller-Optimizer	\$999,949	6/30/2009
Renewables	PIR-07-011	Green Volts, Inc.	Low Cost Installation of Concentrating PV	\$250,000	4/29/2009
Renewables	PIR-07-015	Gaia Power Technologies	Modular Turnkey Energy Storage Systems for Integration with Photovoltaics	\$247,816	1/15/2009
Renewables	PIR-08-031	Los Angeles Community College District	Energy Demand Optimization Program for L.A. Trade Tech's F Building	\$2,000,000	6/30/2009
Renewables	PIR-08-033	Advanced Power and Energy Program - UC	Piloting The Integration and Utilization of Renewables to Achieve a Flexible and secure	\$948,903	7/29/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
		Irvine	energy Infrastructure		
Renewables	PIR-08-034	Redwood Coast Energy Authority	Planning for Renewable-based Energy Security and Prosperity in Humboldt County	\$199,988	6/30/2009
Renewables	PIR-08-035	UC Davis	West Village Renewable-Based Energy Secure Community	\$1,994,322	7/29/2009
Renewables	PIR-08-036	UC Merced	Piloting a Integrated a Renewable Energy Portfolio for the UC Merced Community	\$1,000,000	8/1/2009
Renewables	PIR-08-037	Southern California Edison	Proposed Deployment Study of a high Penetration of Renewable Energy on Santa Catalina Island	\$200,000	6/30/2009
Renewables	PIR-08-038	Sonoma County Water Agency	Renewable Energy Secure Sonoma County	\$1,000,000	6/30/2009
Renewables	PIR-08-039	County of Alameda	CERTS Smart Grid Demonstration with Renewables and large-Scale Energy Storage Integrated at Santa Rita Jail, Alameda County, California	\$1,983,555	7/1/2009
Renewables	PIR-08-042	Makel Engineering Inc.	Biogas Fuelled HCCI Power Generation System for Distributed Generation	\$300,000	7/29/2009
Renewables	BOA-99-209-P	The Regents of the University of California, Office of the President - CIEE	Strategic Planning Research for integration of Renewable Energy Collaboratives	\$119,996	1/15/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Renewables	PIR-08-041	Summers Consulting, LLC	Energy, Economic and Environmental Performance of Dairy Bio-power and Bio-methane Systems	\$999,925	8/1/2009
Renewables	500-98-014	Son Rise Solar	Low Cost Parabolic Trough	\$55,500	2/1/2009
Renewables	500-08-017	UC Davis	California Renewable Energy Collaborative - Research Program Plan for Renewable Energy	\$3,014,727	4/27/2009
Renewables	PIR-08-032	Local Power Inc	San Luis Obispo RESCO	\$198,167	6/30/2009
Renewables	PIR-08-040	El Dorado Irrigation District	El Dorado County Water Systems Energy Generation, Storage, Efficiency, Demand Management & grid Support Project	\$197,950	7/29/2009
Renewables	KEMA-06-023-P-R	KEMA, Inc.	Research to Evaluate the Impact of Wind Generation, Storage, and Demand Response on the California Grid	\$93,793	5/26/2009
Renewables	NCI-06-028-P-R	Navigant Consulting, Inc.	Utility-Scale Renewable Energy Roadmap	\$149,991	4/20/2009
Renewables	NCI-06-029-P-R	Navigant Consulting, Inc.	Renewable Energy Secure Buildings Roadmap	\$150,000	4/20/2009
Transmission and Distribution	500-08-027	California State University, Sacramento	SmartGrid Information Assurance and Security Technology Assessment	\$200,000	5/29/2009
Transmission and Distribution	BOA-99-208-P	The Regents of the University of California, Office of the President - CIEE	WECC Load Modeling	\$160,349	1/2/2009
Transmission and Distribution	BOA-99-219-P	UC Berkeley	Underground cable research	\$787,042	5/4/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Transmission and Distribution	BOA-99-231-P	UC Berkeley	Modeling, the Development of Load Control Strategies and the Integration of Electric Generators Driven by Renewable Resources.	\$425,600	8/12/2009
Transmission and Distribution	500-08-025	San Diego Gas & Electric Company	SDG&E Sustainable Community Smart Grid Demonstration	\$2,808,926	5/28/2009
Transmission and Distribution	500-08-048	Electric Power Group	Demonstration of Advanced Synchrophasor Technology for the Integration of Renewables on the California Grid	\$1,699,149	6/30/2009
Transmission and Distribution	500-07-030	University of Southern California	Strategies to Minimize All Hazards Impact on the Southern California Electrical Power Grid	\$500,000	3/4/2009
Transmission and Distribution	PIR-08-026	EDM International, Inc.	Evaluating the Effectiveness of Avian Interaction Mitigating Measures and Processes	\$165,516	6/30/2009
Transmission and Distribution	500-08-054	Lawrence Berkeley National Laboratory	Synchrophasors for the Integration of Renewables	\$550,000	6/30/2009
Transportation	500-98-014	Worcester Polytechnic Institute	Flywheel Hybrid with Switch-Mode Continuously Variable Transmission Concept Validation	\$87,027	4/30/2009
Transportation	500-98-014	Spark Technologies	Evaluation of Porosity Additives in Lithium Ion Batteries	\$84,550	4/30/2009
Transportation	500-08-022	University of Missouri, Columbia	The Advanced Natural Gas Fuel Tank Project	\$1,000,000	5/28/2009
Transportation	BOA-99-238-R	UC Los Angeles	Development of a Research Roadmap for Energy in Sustainable	\$300,000	6/1/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals

SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
			Communities		
Transportation	ICF-06-034-P-S	SDV-SCC, Inc.	LNG Infrastructure Research	\$23,731	7/15/2009
Transportation	500-08-047	National Energy Technology Laboratory	Automotive Thermoelectric HVAC Development and Demonstration Project	\$2,000,000	6/30/2009
Transportation	500-09-004	Gas Technology Institute	Purification and Liquefaction of Biomethane Landfill Gas for Transportation Fuel	\$992,903	11/11/2009
Transportation	500-09-008	UC Riverside	Hydrogasification Research and Demonstration	\$994,524	9/14/2009
Transportation	BOA-99-214-P	Center for the Built Environment - UC Berkeley	Cool-colored cars to reduce air-conditioning energy use and reduce CO2 emissions	\$250,000	1/23/2009
Transportation	BOA-99-237-R	CE-CERT	PIER AFRR Gaps Analysis and Research	\$ 400,000	9/1/2009
Transportation	PIR-08-044	Gas Technology Institute	Ultra-Low Emissions, 12-13 Liter Heavy Duty Natural Gas Engine Development	\$1,000,000	7/15/2009
Transportation	PIR-08-045	Westport Power, Inc.	Lower Cost High Performance and High Efficiency Pilot-Ignited Directly Injected HD Natural Gas Engine	\$998,844	7/15/2009
Transportation	PIR-08-046	Volvo Technology of America	Gas Optimized Advanced Heavy Duty Engine Concept	\$999,970	8/12/2009

Details of Calendar Year 2009 Projects by SB 1250 Policy Goals					
SB 1250 Goal	Agreement Number	Company Name	Project Title	Project Amount (dollars)	Start Date
Transportation	PIR-08-047	NASA Ames Research Center	Algae OMEGA: offshore membrane Enclosures for Growing Algae	\$793,576	9/1/2009
Transportation	PIR-08-048	Solazyme, Inc.	Production of Soladiesel RD (TM) from Cellulosic Feedstocks	\$789,697	7/1/2009
Transportation	PIR-08-049	Menon & Associates	On-Site Aerobic Fermentation of California Cellulosic Agricultural Waste into Biofuel	\$800,000	7/1/2009
Transportation	MRA-02-083	UC Berkeley, Global Metropolitan Studies Center	Assess New Transportation and Land -use Patterns in a Carbon-constrained Future	\$250,000	7/1/2009
Transportation	500-08-058	National Renewable Energy Laboratory	Natural Gas Vehicle Research: Industry Applications	\$300,000	6/30/2009
Transportation	500-08-043	Westport Power, Inc.	Certification and Field Demonstration of a 0.2 g/bhp-hr NOx HPDI LNG Truck	\$500,000	6/30/2009
GRAND TOTAL				\$97,455,406	